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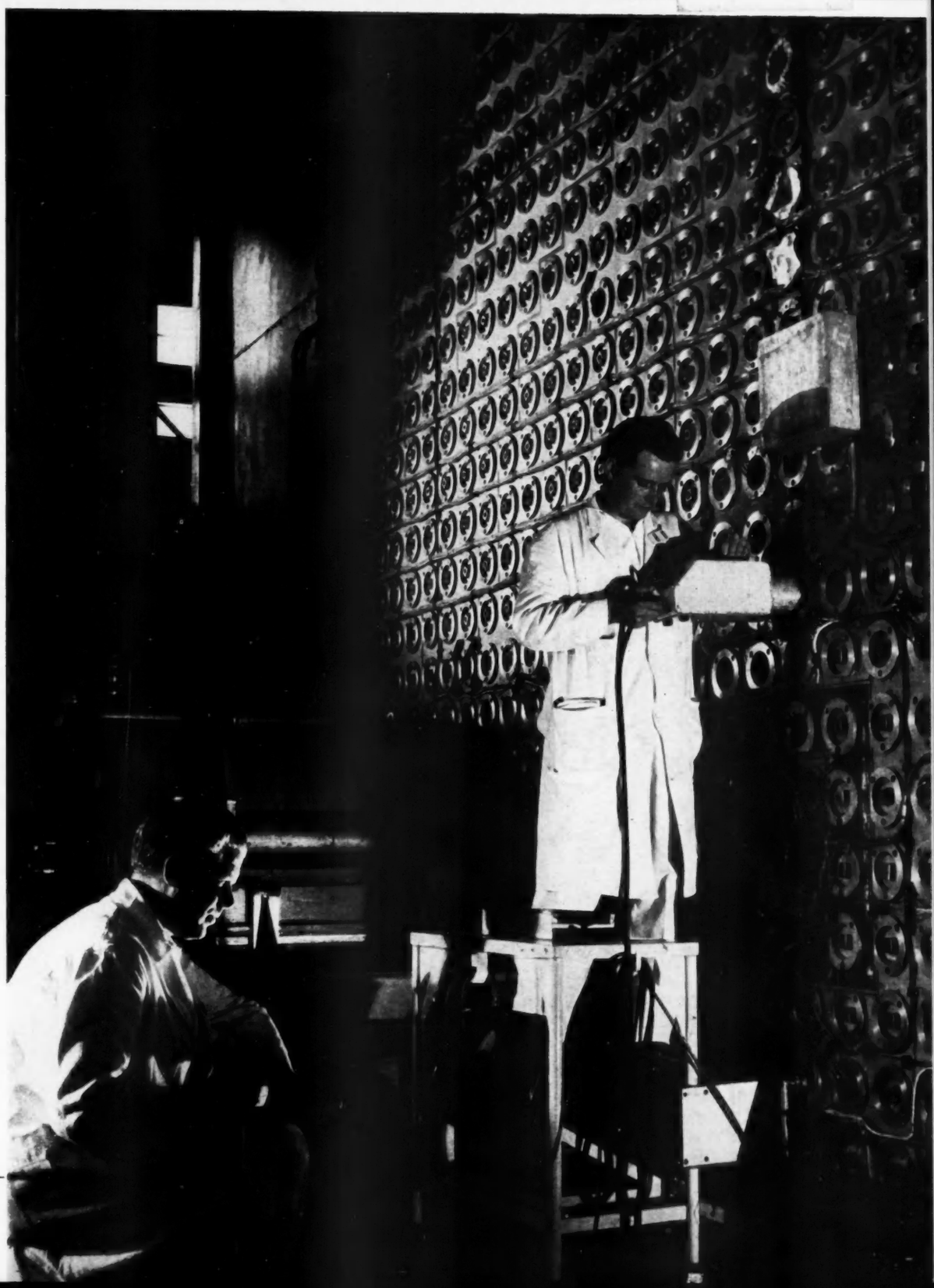

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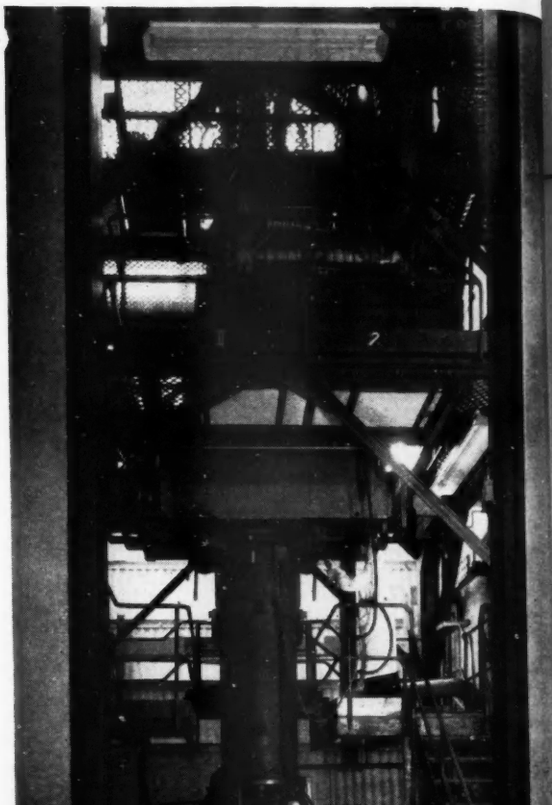

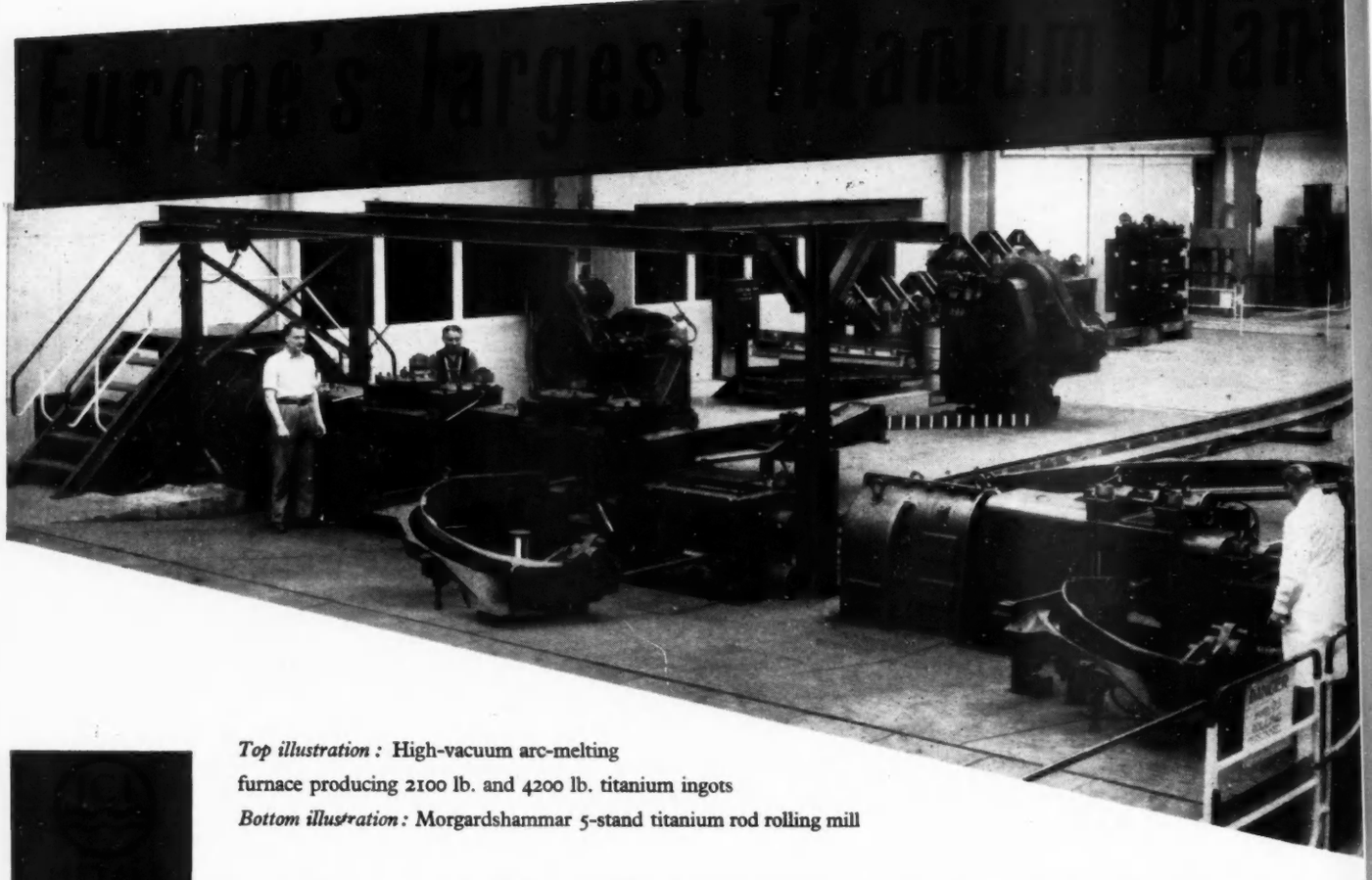

Top illustration: High-vacuum arc-melting furnace producing 2100 lb. and 4200 lb. titanium ingots
Bottom illustration: Morgardshammar 5-stand titanium rod rolling mill

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ENGINEERING

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No Nonsense

We took half a day off recently and played the new Management Decision Game with the aid of an electronic computer. The big chemical companies, soap companies and the like actually have people who spend their working hours playing games of this kind, or something rather like them, but the small or medium firm, we thought, is not therefore compelled to throw up its hands in despair. It can devote at least a few of its precious man-hours to a little looking and thinking.

A mechanical engineer feels abashed when confronted with an electronic computer. As an engineer he ought to understand the machine; other people expect him to understand it. So if he has not got round to delving into the mysteries of computers, he avoids situations where he is brought face to face with them. He reassures himself by the thought that if at any time he has to come to grips with the subject it will not be difficult for him, an engineer. Meanwhile, he is very busy on other more urgent work. But meanwhile, too, such marginal managers as accountants and company secretaries are going ahead. Like cavalry officers in tanks, they have no idea how the wretched thing works, but they use it with a delightful nonchalance and win the battles of the boardroom.

So we pocketed our pride. We would use a machine which we did not fully understand. At the London office of International Business Machines, where the Game was played, little notices adjured us to "Think." Was this fair; was it reasonable, as Mr. Doolittle would have said? Surely these machines were intended to do all the thinking for us? No, Sir! Half a day in the rarefied atmosphere of that Wigmore Street office set us thinking as we have never thought before. It is like driving a car instead of walking. A car is a faster means of transport than walking, but you have to do a lot more thinking when you are driving than when you are walking, and if you sit behind the wheel of a hundred-mile-an-hour car you have to think quickly and think well ahead. But you certainly move in a car like that. It's exhilarating—and that is the very word to describe the sensation of working with a computer in the Management Decision Game. You pack more into those few hours than most managers in as many years.

About twenty visitors joined in. We were split up into three syndicates and each syndicate was supposed to be taking over the board of a company making a certain product —unspecified but at present sold at £40 each retail. We found it useful to think of them as washing machines. The three companies make the same product, and so far have all sold their products at the same price. But none of them is doing well; the return on investment is small and the sale price leaves only a small margin of profit. The companies are situated in three of the four areas into which the country is divided for sales purposes. It costs more, because of transport, to sell the product in an area outside the company's own area—we were given the figures, as well as figures for sales in each area, gross income, production costs, net income before and after taxation, cash in hand, inventory, plant assets and other information showing the position of the company at the beginning of the quarter for which we had to make plans. Our company decided to try and dominate the market in the fourth area—the area which was common to all companies and was the biggest market by population. We decided to cut the price in that area, and spend more on sales promotion.

We were not to know what the other two companies were planning. The computer had been programmed to receive the plans of the three companies and work out the actual results of the three plans interacting during the quarter. For our syndicate, the result was actually a lowering of sales and a reduction in cash available. We were then given another chance—evolve a plan for the next quarter. We adopted new tactics, but this time the computer refused to accept our planned figures—we had made a simple arithmetical error.

IBM are careful not to claim that a company's policy can be decided in precisely this way. The object of the Game is to provide experience in making management decisions, by allowing managers to juggle with the principal variables in a business and see the effect, all within a few hours. Such an exercise is the beginning of managerial wisdom. We were ignoring all the trivialities which normally obscure managers' vision. Some of those trivialities may profoundly affect the fortunes of a business in real life, but they might be isolated and controlled if someone had the courage to work out the equations to the business and get a computer to help in solving the equations. A few years ago this idea would have seemed nonsensical, but the line between sense and nonsense has always been vague. Today it is constantly being pushed forward. To take part in that Game was to be faced with a challenge: could we, for example, use a computer?

Cover Picture.—*Determining the radiation evel outside the plugs that fit into the unloading channel of BEPO at Harwell. The steel and lead coffin into which highly radio-active fuel is put after unloading is to be seen in the background. BEPO (British Experimental Pile Zero) was one of the first reactors ever built; it has a (heat) capacity of 6·5 MW.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

When I was with Cator and Bliss, there was another apprentice who knew just what was wrong with the company. He had read Greats at Oxford and it had clearly improved his critical faculty, though what he was doing in an engineering firm I never discovered. " Look at purchasing," he said, " it's crazy. They get their bar from Spartacus Industries, who buy it from Clapton Steels. We pay Spartacus and Spartacus pay Clapton. And Clapton, believe it or not, are a subsidiary of ours. Why don't they just put it in a truck and send it over? Fantastic ! " I mumbled something about submitting a memo to the managing director, and went on filing the edge of a stainless-steel plate.

It's not always easy to see why things are done in a certain way, particularly in a world that has become so complicated. " Whyever do the car-tax people want to know where I keep my car? " is a familiar complaint. But perhaps to someone capable of understanding the labyrinthine machinations of the Inland Revenue, there is some perfectly sound and valid reason.

I must confess I rather sympathise with those people who sat tight on the underground when an official, in contradiction to the destination indicator, cried stentoriously " All change " ; and feel a similar malevolence myself when the 88 bus decides to go no further than Tooting Broadway—the driver, I convince myself, wants to knock off early so he can watch Quatermass on TV ! But in fact, we are just an ignorant lot, allowing our indignation to get the better of our good sense, and failing to appreciate the complexities of a difficult operational situation. All understood, presumably, should lead to all forgiven.

The answer, one might suppose, would be better public relations: explain to the public, to the workers, to managers, users, salesmen and savages precisely what is going on. But that isn't always quite so easy. The way a job is done may be the result of a long and complicated operational research study requiring the services of countless brainy statisticians. " We've worked it all out and this is the best way " is poor material for a public relations man.

But are we, in our ignorance of complex modern procedures, to sit back on the assumption that big brother knows best? Or are we occasionally to rebel?

Incidentally, my friend at Cator and Bliss did put in the memo. He is now company secretary; but they still get their bar from Spartacus who buy it from Clapton Steels.

CAPRICORN

Weekly Survey

Flight from an Impoverished World

The urge to hit or orbit the moon with a missile and to visit outer space is excellent in its way. As an idea it is also capable of getting out of control. To a large extent the conquest of space is a long-term investment for future generations. The higher the priority of space research is driven the more likely it is to lower the standard of living of the present generation and the more likely is it to reduce the resources available for other types of research and development. A high priority for such work and a vast outlay upon it increases the scope for the state planners, since the development of space research requires heavy national subsidies.

These considerations should be borne in mind at the present time when working populations in industrial communities are already carrying a heavy burden of education for the young and pensions for the old. The current rivalry in space development may seem to be the fashionable alternative to an armaments race and may, of course, in the end be indeed a kind of armaments race, since there are many direct and indirect military dividends to be gained. Nevertheless, a good deal of the expenditure will be a kind of Chinese warfare in the foreseeable future, in which armies of engineers and scientists compete but on one ever fights.

A flavour of this attitude of mind can be seen in such remarks as those of Mr. D. W. Douglas, chairman of Douglas Aircraft Company Incorporated, who said some time ago (his address is published in the December issue of the *Journal of the Franklin Institute*): " Today's most pressing aim in the look to outer space is toward the admittedly difficult—perhaps unobtainable—goal of full performance reliability. We want to hit—or orbit—the moon, but we don't want to do it as the result of one lucky shot . . . hence the increasing need for an accelerated ' do-it-yourself ' research programme . . . This need for a greatly increased volume of independent research will require the talents and the best efforts of a highly educated and truly dedicated team of men and women . . .". This is all very true, but the economies of the West must keep their feet on the ground and their heads out of orbit if space research is not to run the dangers of becoming a complex form of impoverishment.

Hooks on Germany

The opening of the European Common Market has focused attention on the number of foreign firms with subsidiaries or interests in the six countries. Although the Netherlands has been the principal goal of most of the companies, it is not generally realised how far this penetration has gone in Western Germany. The United States has main interest in more than 40 German firms covering the whole range of manufacturing industry.

In metal-working the Montan-Union of Hamburg is wholly American owned, and in Zinnwerke Wilhelmsburg the National Lead Company of New York has a half interest. American capital has been widely invested in chemicals, including Deutsche Plax, Atlas-Goldschmidt, Chemische Fabrik von Heyden and Lederie GmbH of Munich. A number of American oil companies have wholly or partly owned subsidiaries in Germany. General Motors own the Adam Opel AG, and Ford own the greater part of Ford-Werke AG, Cologne.

Britain has a substantial or majority holding in between 20 and 30 German concerns. These include Diamon GmbH, largely owned by Ever Ready, the BP subsidiary BP Benzin und Petroleum AG, Courtauld's German affiliate, Glanzstoff-Courtaulds, Deutsche Marley Fussboden, which belongs to Marley Tiles Limited, and important insurance interests. Switzerland has considerable capital invested in German banking and finance houses. French and Belgian steel firms and the Luxembourg steel combine Arbed all have interests in German coal and steel. The French oil giant, Compagnie Française des Petroles, has a smallish wholly owned subsidiary at Düsseldorf, the Deutsche Total Treibstoff. In all it is estimated that there are over DM 2,250 million (say £225 million) worth of foreign capital in west German industry today.

Coal Cuts its Losses

In contrast to ministerial statements of recent months the National Coal Board have revised downwards their estimates of future coal demand. It is no longer believed that a level of 240 million tons a year by 1965 is a realistic target and it has been recognised that the competition of oil can only be met by cheaper coal.

Sir James Bowman last week described the situation as " a struggle for the life of coal in Great Britain." During 1958 the demand for coal fell by about 10 million tons and about half of this was due to competition from oil. The consumption of oil in cases where coal can be used rose from about 19 million tons of coal equivalent in 1956 to around 28·3 million tons last year. Although the Board did not believe that price reductions would help greatly at present in reducing stocks (those in the hands of the NCB amounted to 17·6 million tons at the end of last November) the price mechanism will be used to a greater extent in the future to adjust supply and demand.

Though output has dropped very appreciably during the past year, productivity rose. The output per man-shift was 3 per cent higher than the previous year and reached its highest level yet. Production costs were 3*s* a ton lower, and while the Board had anticipated a £30 million loss the figure achieved was actually below £10 million. The future promises further difficulties; the Board's wage bill in the next year will be £10 million higher, and the savings from closing 36 uneconomic pits must be set against the losses which will result from the 25 per cent cut in opencast production. The demand for a shorter working week for underground workers would, if accepted, cost an estimated £40 million to £50 million a year.

Sir James Bowman emphasises that the Coal Board would regard pit closures as a last resort and that short-time working was wholly uneconomic. The reduced demand would be met so far as possible by cutting recruitment and adding to stocks.

Meanwhile investment in the mines will continue at a level of about £100 million a year. The proportion of coal power-loaded in 1958 was 28 per cent compared with just over 23 per cent in 1957 and presumably this proportion will continue to rise.

Machines for Teaching

Those who have argued in favour of introducing a course in the humanities into university engineering curricula will be interested in the remarks of Dr. Folsom, who was recently inaugurated as president of Rensselaer Polytechnic Institute in the United States. In his address he said that the next ten or fifteen years would see the development of a new curriculum which would be " pre-engineering " in its flavour. It would stress engineering science, the basic sciences and the humanities. This curriculum would take the place of the present undergraduate curricula in aeronautical, mechanical, civil,

electrical, chemical, metallurgical and management engineering. The Institute will probably award a B.S. degree for the completion of this four-year curriculum. Thereafter the Institute would consider that graduate work, either in the professional or scientific areas, would be necessary for a complete engineering education.

He went on to say that the problem of teaching a very much higher number of undergraduates in engineering in the United States could not be met by doubling the number of teachers. The only way of raising output from limited teaching resources (and no doubt in America as in this country the engineering teaching profession can be extended only slowly owing to the competing attractions of engineering appointments outside academic work) was to investigate teaching methods, and Rensselaer is now engaged in an investigation to this end. Part of this problem of raising output may be solved by the greater use of capital equipment. For example, the greater use of closed-circuit television and film strips has been found to increase the teaching possibilities in delicate and small experiments.

The American solution, therefore, appears to be on the lines of more capital-intensive methods of teaching. It is a straightforward substitution of equipment for scarce labour, but it assumes that the capital is the less scarce commodity of the two. This is more true in the United States than anywhere else in the world, but it is directed towards devices for handling large classes efficiently rather than lush equipment for the individual undergraduate.

State of Eastern Europe

Industrial output has risen in all the countries of Eastern Europe except Albania, according to a report issued by the United Nations Economic Commission for Europe. This states that the gross output plan for the first nine months of 1958 has been exceeded by a fairly large margin. Better supplies of raw materials and energy have been the main factors contributing to this success. Another cause was the relatively good harvests of 1957. Electric power supplies have increased everywhere at least up to the planned level. Productivity has risen with the faster flow of materials and fuel. A similar improvement is reported from the Soviet Union, in spite of a reduction in the working day in the ferrous metals industry and the Ukrainian coal mines. Investment programmes in several countries, on the other hand, have been hampered by shortage of building materials and labour. The Soviet chemical industry is now developing heavy investment, although less rapidly than forecast. With rapidly growing supplies of consumer's durables, five East European countries have introduced hire-purchase schemes for the first time.

Hungary is an exception to the general picture of expansion in Eastern Europe. There, industrial output is actually less than in the fourth quarter of 1957. Investment activity in Hungary is at a slow rate and it looks as though the period of stagnation is likely to continue. From Eastern Germany the big event was that 19 years of food rationing ended in May. The new prices are higher and have been followed by wage increases totalling DM 2·8 billions a year.

So far as trade with Western Europe is concerned, there was a slowing down of the rate of increase last year. The trade of the East European countries with the Soviet Union increased much more rapidly than either their trade with Western Europe or between themselves. The relaxation of strategic controls will undoubtedly ease West European exports, including engineering products, to the Soviet Union.

Crowded Flying

The various problems of ensuring the safety and expediting the flow of air traffic have been causing increasing concern over the last few years to the national control authorities and their executive officers. In particular, the imminent large-scale use of jet aircraft over the North Atlantic threatens to add unbearably to the burden already carried by air traffic controllers in these areas. Speaking before the Royal Aeronautical Society in London recently, BOAC's deputy flight service manager, Mr. E. W. Pike, said that the mounting volume of North Atlantic air traffic moving during peak periods was already involving almost intolerable work pressure on traffic controllers. The introduction of jet aircraft would cause an early crisis in the control organisation, that could only be averted if the operators collectively appreciated fully the threat to their economy.

Whereas the economy of piston-engine aircraft is not greatly affected by large changes in altitude, if the long-range jet is not operated reasonably near its optimum, heavy penalties must be paid in carrying extra fuel and correspondingly reduced payload. On current standards and procedures, the operator is free, within certain limits, to select his own flight track; but once the plan is filed the pilot must stick to it, and he must fly at the altitude assigned to him by the controller of the area in which he is flying; this altitude in turn is dictated by the necessity to maintain a vertical separation of 2,000 ft, above 29,000 ft altitude, or 1,000 ft, below 29,000 ft altitude, between aircraft whose paths are to cross.

Mr. Pike's view is that operational freedom in the vertical plane is essential for a jet aircraft. Operators should, therefore, be prepared to accept a fixed route network—as in general they do over land routes, but which so far they have not been ready to consider over the Atlantic. With a system of co-ordinated tracks, navigation aids such as Dectra can provide accurate track guidance over the whole crossing and would enable the present standards of lateral separation (120 nautical miles) to be drastically reduced. An airborne separation monitor could enable the distance between adjacent aircraft on the same track to be accurately indicated in the cockpit. Better air/ground communication, and improved information and display techniques at air traffic control centres will be required, with a gradual move towards automatic computation.

Housewives in Hordes

Something like an *embarras de richesses* has afflicted the sections of the light engineering industry making domestic appliances. Towards the end of November the Parliamentary Secretary to the Minister of Power said: "People are coming in hordes and droves to buy on hire purchase." The relaxation of controls on domestic appliances was decided upon in order to give a quick stimulus to consumer durable goods and hence to the economy as a whole. The policy has certainly succeeded. The nationalised gas and electricity industries are faced with the problems of over-trading, especially a shortage of working capital.

When the credit squeeze was started in 1956 the Government decided that these boards should not be allowed to increase the amount of working capital involved in hire-purchase transactions, and the accounts for 1956-57 indicated that the upper limit was about £60 million. So long as the credit squeeze lasted there was no danger of the two industries going through their 1956 ceiling, but since the initial deposit dropped from one-third to 10 per cent a very big demand has developed and private electrical retailers have much to say about the use of public funds to subsidise hire-purchase agreements with nationalised industries. More is likely to be heard about this problem when the Electricity (Borrowing Powers) Bill has its second reading on 20 January. According to this bill the total amount which the Electricity Council and Boards may borrow will be increased to £1,060 million. The bulk of this will be for generation and distribution, but part of it may be used as working capital for hire-purchase sales.

Letters to the Editor

JOHN LEWIS PARTNERSHIP

SIR, On 2 January, ENGINEERING wrote that "some employers, such as Mr. John Spedan Lewis and Mr. Wilfred Brown, have sought to associate their employees directly in the formulation, if not the execution, of policy." ("Sink or Swim Together," page 1.)

I ought, I think, to mention upon this that the declared aims of the experiment in co-operative production that is embodied in the John Lewis Partnership, include not only a complete transference of profit in the strict sense of that word (the results in this way exceed already £6 million) from those who provide capital and management, to the managed (whose status is thus changed from that of cattle to be, howsoever tactfully, exploited, to that of clients to be served), but include also association of employees, not merely in the formulation but in the execution of policy. Such association must obviously be limited by the very great inequalities of natural ability and of other luck in life. In the very best event, the particular experiment that is embodied in the John Lewis Partnership will need many further years before it will have done all that I hope and fairly confidently believe that in due course it will, to throw light upon these limited possibilities.

At the time of my own retirement, in September of 1955, from any authority in the Partnership's affairs, it was in this, as in many other respects very much less mature than by then it might have been, but for certain major hindrances. Even if, however, in those respects its luck and my own had been ideally good instead of very bad, the process of trial and error must still, I think, have been far short of anything like complete exploration of this very difficult but very important ground.

I am, Sir, yours faithfully,

J. SPEDAN LEWIS.

Longstock House,
Stockbridge, Hants.
9 January, 1959.

CLEAR THINKING NEEDED

SIR, May I refer to the letter by Mr. F. Porges, under the above heading, published on page 3 of your issue of 2 January?

I must charitably assume that Mr. Porges has not read the Industrial Welfare Society's booklet *Successful Suggestion Schemes*, for his remarks, which offensively imply the inability of the Society to do their job, would otherwise be inexcusable. Mr. Porges surely does not believe that the yardstick chosen to measure "success" was chosen "without stopping to think" whether it meant anything? Of course not! If Mr. Porges will turn to page 26 of the booklet he will read "one is, therefore, forced to use somewhat crude mechanical formulae. . . . It is easy to criticise any of these formulae. . . ."

Five main objections are then listed and admitted to be "valid to some extent." The report, however, then goes on to cover the points made by Mr. Porges in his first paragraph: "No one would argue that a Scheme which received 80 suggestions per 100 employees, adopts 30 of them and finds that 15 give tangible financial economies, is not a better scheme than one which receives five suggestions per 100 employees, adopts two of them and finds that one gives a tangible saving."

The example quoted by Mr. Porges is not one which is borne out by experience. Indeed, the survey reveals that the average acceptance rate is 33·7 per cent and that only three companies accepted less than 10 per cent of the suggestions submitted. Obtaining suggestions is rather like catching fish. The wider one can cast one's net, the more chance there is of catching some big fish, although the proportion of small fish will

Continued on next page

Continuing

Letters to the Editor

also increase, of course. Experience also tends to show that the percentage of ideas adopted varies little whether one is receiving 500 or 5,000 suggestions a year. Obviously, therefore, the more suggestions one can encourage, the better. The response rate as used by the Society, unsatisfactory as it is in some respects, *does* indicate the enthusiasm with which employees are supporting a scheme, and *is*, therefore, of interest. Incidentally, the Industrial Welfare Society is in good company, because the National Association of Suggestions Systems in the United States uses the same yardstick.

Finally, as one who was closely connected with the IWS in the preparation of this booklet, may I say that I, myself, have often been critical of this yardstick as a means of " comparing " firms (especially as my own company " suffers " by this comparison!). I must accept, however, that it is as fair a guide, taken with the numerous other data given in the survey, as any other. If Mr. Porges can suggest a better yardstick, all of those concerned with the administration of suggestion schemes will be delighted to use it. A constructive criticism of this kind would be of much more value than an inaccurate criticism apparently written " without stopping to think."

Yours faithfully,

R. A. SHEPHERD,
Chairman,
IWS Suggestion Scheme Group.

289 Corbets Tey Road,
Upminster, Essex.
7 January, 1959.

DESIGN OF STEEL BUILDINGS

SIR, Dr. Jacques Heyman's article on " Automatic Design of Steel Buildings," on page 834 of ENGINEERING of 26 December is just what was needed, putting in a nutshell the salient points of recent work on plastic theory. Two points in the introductory remarks, however, seem to call for comment.

Few knowledgeable people would dispute the claim that " engineering is one of the few truly creative intellectual disciplines," but the later statement that—" The conventional engineer does not in fact *design* at all. In almost all so-called design, the engineer will guess the shape and size of a structure, and then apply the mathematical tools at his disposal in order to find the working conditions of this trial 'design'," seems very wide of the mark.

This misses the real meaning of the word *design*. The process described as " guessing the size and shape " is, in reality, the exercise of judgment. No valid calculations or mathematical support for this judgment can be done until afterwards, for checking its correctness in so far as the physical sciences can so do.

This is the basis of all engineering design, whether we are dealing with an aircraft engine gearbox, a gasholder, or a precision machine tool. The sketch design comes first, a general grasp of the thing as a whole, to see where the weak points lie, where further attention will be needed, and to form the basis for detail improvements in construction. This work provides the data for that " precise question " to which the machine *may* give " the exact answer."

Yours faithfully,

HUGH CLAUSEN.

17 Harman Drive,
London, N.W.2.
7 January, 1959.

SIR, In his interesting article, Dr. J. Heyman mentions the use of an electronic computer to design steel frameworks for buildings. Computers appear to be helpful, if expensive and unwieldy, tools for the solution of complex problems. In aircraft structural design, for instance, the loads may be known to a high accuracy, the working tolerances are fine, the safety factors must be cut to a minimum. The stress analysis of the structure must be pressed to the limit with little regard for computation expense. A computer can be used in many cases with a reasonable knowledge that the vast arithmetic it will perform is based on information matched to its accuracy, and its results will be of a necessary exactitude, which will be exploited by accurate workmanship and highest quality materials.

In building frames, however, as Dr. Heyman indeed explains, the loads are not known accurately, workmanship is to less fine limits, materials are of lower quality. None of these are necessarily undesirable—an alarum clock need not be made to the limits of a wrist watch. The use of a computer for the design of building frames would seem to be scarcely justified by, either the data which could be fed in, or the practical but sensible crudity of the construction.

The plastic design theory advocated by Dr. Heyman for use with a computer is indeed a valid theoretical approach in gaining knowledge of structures. Furthermore, the very many experimental tests carried out at Cambridge and elsewhere have confirmed the theoretical predictions of the collapse behaviour of structures. However, it is not yet clear that it is the best basis for design. For the difference between a plastic and an elastic design is a difference in the relative proportion of the members. The actual strength depends on the safety or load factors used. These are largely independent of the method of design.

Another way of putting it is that the parts of a plastically designed structure would have a constant strength against collapse, whereas the parts of an elastically designed structure would have a constant working stress. The plastic design, therefore, would have the higher strength/weight ratio at collapse and the elastic design would have the higher strength/weight ratio under working loads. (Higher strength/weight ratio in the elastic case is here taken to mean a lower weight in a design in which nowhere is the working stress exceeded.) The argument resolves into whether it is better for a structure to be " well-balanced " at collapse or under working loads.

That actual working stresses are incorrect owing to prestressing during erection, etc., should not necessarily lead to elastic methods being dismissed as " irrational." For a plastically designed building does not escape such incalculable stresses just because of its design procedure and all the tests of frames, however designed, appear to give initial linear (elastic) load/deflection curves, at any after " shake-down." Would it not be possible, therefore, to consider the calculable elastic stresses, which are superimposed on erection stresses, etc., as the basis for elastic design? The theoretical and practical work on the collapse of structures, together with the well-known high ductility of structural steel, is essential to justify the neglecting of residual, erection stresses, etc., but the " balance " of the design should, in my opinion, be determined by elastic calculations at working loads.

Plastic methods may, I suspect, lead to designs in which the disposition of material may not give the best rigidity at working loads and/or beyond working loads. Rather than designing for collapse and checking for deflections under working loads, I would suggest that steel frames should be designed under working loads and, if possible, the behaviour of the design investigated up to collapse. For most buildings should stand up, not just not fall down.

Yours faithfully,

W. J. SUTCLIFFE.

Department of Mechanical Engineering,
The University of Liverpool.
7 January, 1959.

Obituary

DR. HANS SULZER

The death occurred on 3 January, 1959, at Winterthur, Switzerland, at the age of 82, of Dr. Hans Sulzer. He was president of the Swiss engineering company of Sulzer Brothers Limited, and senior member of the Board of Sulzer Brothers (London) Limited, makers of diesel engines, pumps and compressors. Especially well-known are their cross-scavenged two-stroke diesel engines for marine propulsion which they have recently developed by turbo-charging.

In addition to his family interests in the engineering field, Dr. Sulzer—who was a lawyer—played a leading part in the industrial and economic life of Switzerland. He had a particular interest in industrial relationships between management and labour. His activities embraced banking, insurance and mining, and he served on the boards of several companies. He also played a leading part in the affairs of the Swiss and International Chambers of Commerce.

During the 1914-18 War, Dr. Sulzer represented his country in Washington, and when, after the outbreak of the last war, the economic situation of Switzerland became precarious, he was invited by his Government to lead a mission to London to seek recognition of Switzerland's position as a neutral country and assurances and assistance with regard to essential supplies of food and materials.

MR. HENRY OSWALD

British Brown-Boveri

By the death of their managing director, Mr. Henry Oswald, at the comparatively early age of 56, British Brown-Boveri Limited, London, have been deprived of the services of one whose whole working life has been devoted to promoting the interests of the Brown Boveri organisation. His death, which followed a long illness, occurred at his home at Surbiton on 8 January.

Born at Aadorf, Switzerland, on 23 September, 1902, Mr. Oswald received his early education at the Canton of Thurgau Secondary School, Aadorf; and between April, 1918, and March, 1923, spent two periods as a day pupil at the Technical College of the Canton of Zurich, at Winterthur. While at the Technical College, he gained the Diploma in Electrotechnology. His practical training, extending over two years, was received at the works of Brown Boveri and Company Limited at Baden and was sandwiched between his periods at the college. There followed a four-year course at the Federal Technical University, Zurich, as a result of which he secured a first-class State Engineering Degree in July, 1927.

In January, 1928, he joined British Brown-Boveri as a contract engineer and served in that capacity for about four years. There followed a period of residence in India, from 1932 until 1937, during which he acted as representative and resident engineer in that dominion (as it was then) for the Brown Boveri company in Switzerland.

Returning to Britain in 1937, Mr. Oswald was appointed general manager of British Brown-Boveri, in which position he continued to serve until 1947, when he was promoted to be managing director. He was made a director of the company in 1941.

For many years, his work entailed the responsibility for the technical execution and erection of Brown Boveri machinery in Great Britain, South Africa and elsewhere. He was largely responsible for the development of an auto-controlled electric double-tunnel kiln for the high-temperature biscuit and glost firing of ceramic ware, which is understood to have been the first of its type to be installed in this country.

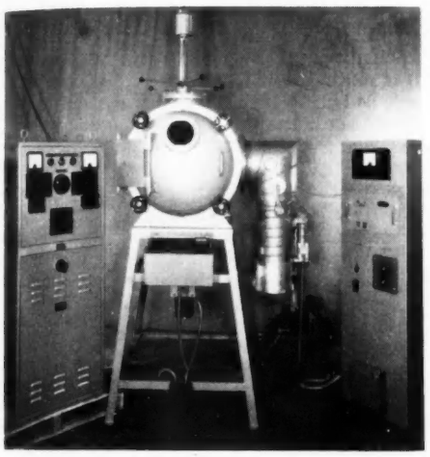
Mr. Oswald became an associate member of the Institution of Electrical Engineers in 1938 and an M.I.E.E. in 1943.

Plant and Equipment

INSTRUMENT RANGE

1958 saw the wider application of scientific instruments. The IGY was in full swing and created new demands: more instruments for operation in the field were required—sometimes for arduous conditions, such as are found in Antarctica. Instruments were also needed for earth satellites and rockets, not only for use in outer space but also for observing the high flying objects from the ground. In the laboratory, too, requirements become more rigorous: greater accuracy is called for and ease of use is of ever increasing importance. The pace of research is quickening and time cannot be wasted on instruments requiring involved manipulation.

The response the instrument industry is making to the changing demands is shown by the 43rd Physical Society Exhibition. (It runs from 19 January to 22 January and is held in the Old and New Halls of the Royal Horticultural Society, London.) On display is a wider range of instruments than has been seen at previous exhibitions, and the influence of the events of 1958 can be clearly seen. More optical instruments are on show—a 6 in Newtonian astronomical telescope, for example; instruments designed around the principles of applied psychological research are to be seen; an increased number of rugged, transistorised equipments suitable for arduous field conditions are on view; data processing techniques are playing a greater part in the design of instrument systems; and in addition the development of instruments of greater precision is evident. Some of the items displayed are described in more detail below and others will follow in a subsequent issue.



Electron beam apparatus for the flux-free welding of metal.

Electron Beam Welding

An electron beam welding apparatus is displayed by Edwards High Vacuum Limited, Manor Royal, Crawley, Sussex. In operation, electrons from the tungsten filament of an electron gun are accelerated to the work by a high voltage, the work being at earth potential. The beam is electrostatically or magnetically focused and intense local heating can be brought about by the correct choice of electron spot diameter. Welding is carried out by mounting the work on a turntable beneath the stationary gun: welding diameters of up to 6 in can be obtained in this way. The process is carried out in a vacuum of less than 10^{-4} mm of mercury and has proved to be very suitable for flux-free welding of metals particularly susceptible to oxidation difficulties such as loss of ductility. One typical application is the capping of nuclear fuel elements. Power for welding is supplied from a high tension control unit capable of delivering 20 kV at 100 mA.

Surface Roughness Tester

A surface roughness tester that can measure roughness in the range 10 micro-inches to 0·01 in is shown by British Physical Laboratories, Radlett, Hertfordshire. It operates by use of a probe that produces an output potential proportional to the displacement caused by surface irregularities. The potential is generated by the Hall effect. Subsequent amplification of the signal produces a deflection on a 4 in meter. Average or peak readings of roughness can be displayed, depending on the requirements of the operator.

Classifying Germanium

A meter for the routine classification of germanium ingots and slices, in terms of the time constants associated with the recombination of excess electrons and holes, is being displayed by GEC Research Laboratories, Wembley, Middlesex. Ingots are examined by the photoconductance phase angle technique, the phase angle between the reference signal from the photocell and the specimen signal being measured by the vector sum method. Slices may be classified by measurement of the steady-state photoconductance or by the photomagnetoelectric technique.

Transistorised g Meter

A self-contained transistorised meter designed for use with barium titanate or lead zirconate accelerometers, is displayed by J. Langham Thompson Limited, Bushey Heath, Hertfordshire. The output of the accelerometer is taken by way of a cathode follower to the meter amplifier; range switching enables accelerations of 10 *g* and 100 *g* to be indicated as full scale deflection. A nomogram is provided to enable vibration amplitudes to be determined from a knowledge of the frequency and the measured acceleration.

Applied Psychology for Indicating Instruments

A system for drawing rapid attention to a meter showing deviation of a parameter from its "desired value" is shown by the Cambridge Instrument Company Limited, 13 Grosvenor Place, London, S.W.1. The system ensures that the pointer position for the desired value is at the centre of the scale, irrespective of its absolute value: small deviations can then be seen quickly, even from distances at which the scale cannot be read.

In the instrument a short section of a transparent scale is back-projected on to a translucent screen. The section may be adjusted to bring the desired value into line with a fixed datum at the screen centre. This gives the whole scale an effective length of 20 in for a horizontal width of less than 8 in. The pointer image is also projected, like the scale, on to the translucent screen, thus eliminating parallax. When the pointer is in alignment with the fixed datum and the desired value it indicates "no error."

The pointer position for the desired value is at the centre of the scale.

Continuing **Plant and Equipment**

Reading Water Current Directly

A self-contained portable meter for measurement of speed and direction of water flow in the sea or in waterways is displayed by Kelvin Hughes Limited, New North Road, Barkingside, Essex. It is reported that the first prototype of this instrument gave good service at the Royal Society's Antarctic base at Halley Bay. The underwater unit has an oil-filled body carrying the impeller. This transmits its rotation to an internal mechanism by way of a magnetic drive, and its rotation closes contacts to produce six impulses per revolution. A cone mesh tail ensures that the underwater unit is aligned with the water flow and a fluxgate magnetic detector provides heading information. The indicator unit, which is powered from dry batteries, contains a pulse frequency meter to convert the pulse rate from the impeller into a meter indication, scaled from 0 to 3 knots. Direction is ready by manual rotation of a 360° scale until a balance meter reads zero.

Direct-reading water current meter, as used at the Royal Society's Antarctic base.

Infinite Persistence Oscilloscope

An oscilloscope using a " Memotron " cathode ray tube, which enables traces to be stored for any period without deterioration and erased to a fraction of a second, is exhibited by the Solartron Electronic Group Limited, Thames Ditton, Surrey. The instrument, called the Infinite Persistence Solarscope, can be used for the examination of transient phenomena and the production of families of curves without the necessity of repetitive operation. Two vertical deflection channels are provided and simultaneous displays are obtained by high-speed beam switching. The channels have the same characteristics: direct coupled, with a constant bandwidth of 1 Mc/s, and maximum sensitivity of 10 mV per cm. The horizontal channel has the same bandwidth and a maximum sensitivity of 100 mV per cm. Forty-three calibrated sweep times, ranging from 1 microsecond per cm to 10 seconds per cm, are provided. An internally generated waveform with automatic erasing enables focus, astigmatism, and shift controls to be adjusted.

Transfer Function Analyser

Servomex Controls Limited, Jarvis Brook, Sussex, are showing an apparatus under development for the measurement of transmission and phase shift at frequencies below 1 c/s. Rotating synchros are used to generate a sine wave input and it is intended that the equipment shall measure the amplitude and phase of the fundamental at the output in the presence of harmonics and random noise generated by the system. For this purpose, rotating synchros are used to multiply the output signal of the system by the fundamental frequency, in a process analogous to the mathematical technique for finding the Fourier coefficients describing a wave. To remove some of the tedium associated with the phase measurement at very low frequencies, a servo is provided to eliminate the manual balancing operation. It is intended that in its final form the apparatus shall cover the frequency range used for industrial automatic control and be equally applicable to direct current systems or those using a.c. carrier wave.

Ring Slit Sifter

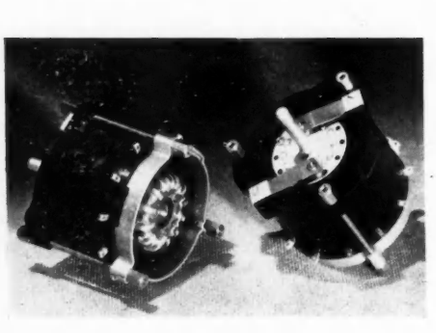
A ring slit sifter for rapidly analysing the distribution of particle size in powders in the sieve range is exhibited by the chemical department of the Research Institute of National Defence, Sundbyberg 4, Sweden. The main parts of the device are a horizontal disc and ring rotating in the same plane at about 1 r.p.m. The disc is slightly smaller than the ring and inside it: the two touch at one point (the " O " point), producing a slit of varying size. While rotating, the device vibrates vertically. The sample of matter is conveyed to the sifter at the O point by a feed device that separates the particles to ensure free movement on the slit. As a result of the rotation and vibration, the particles fall through the slit at the point where the slit widens to their size. Below the slit a drilled block of transparent material receives the particles and displays their size distribution in histogram form. The quantity tested may vary between 0·2 and 2 ml, depending on density and particle size.

Low Frequency Oscillator

A two-phase decade oscillator covering the range 0·01 c/s to 11·2 kc/s is exhibited by Muirhead and Company Limited, Beckenham, Kent. The principle of the circuit is that the overall phase shift of 360° required for oscillation is provided by two electronic integrating circuits, each having a phase shift of 90°, and a sign changer circuit, having a phase shift of 180°. Two outputs, 90° apart, are taken from the integrators and are available at a level of 10 V. Both outputs are directly coupled and have a low direct current content, which can be adjusted to zero. The " 0° " output is suitable for feeding into a load of 600 ohms and is adjusted by an output attenuator down to − 62 dB relative to 10 V; the " 90° " output is suitable for a load of 10 kilohms and is adjusted by a potentiometer. The frequency accuracy is specified as to 0·2 per cent down to 5 c/s, decreasing to 2 per cent at 0·01 c/s. Over the range the output is constant to ± 1 dB.

Counting Press Output

A detector for counting pieces as they leave a press is being shown by Burndept Limited, Erith, Kent. It is designed to operate under conditions of dust and oil that would make the optical systems associated with photocells unreliable. The article to be sensed is blown by compressed air along a glass tube. As it passes through a sensing head, built around the tube, an electrical impulse is produced. Metallic and some non-metallic objects can be detected. The impulse obtained is amplified and applied by way of a magnetic relay to an electro-magnetic counter. In this way the total number of articles made can be determined. The compressed air blowing the piece down the tube is arranged in conjunction with the air supply normally used for removing the part from the press; gravity feed can be used. Articles leaving presses at about 50 ft per second can be detected. To accommodate articles of various sizes, a sensitivity control is incorporated.



Instrument Switch

An instrument switch of new design is being shown by W. G. Pye and Company Limited, Cambridge. Its overall resistance is about 0·7 milliohms, the variation in contact resistance being less than ± 20 microhms. In a life test, twenty million operations were performed with the switch remaining within specification. During the life of the switch, the total resistance drift is less than ± 50 microhms. The thermal e.m.f. generated is not more than 0·008 microvolt per ° C with a uniform change of temperature.

Solid Electrolyte Capacitors

Solid electrolytic tantalum capacitors in which the conventional liquid or paste electrolyte is replaced by a solid semiconducting material are shown by Plessey Company Limited, Ilford, Essex. The result is a reduction in size together with an extension of the working temperature range down to −80° C; satisfactory performance up to 125° C is maintained. Current development work is aimed at increasing the working voltage, at present limited to 35 V d.c., and at furthering the possibilities of miniaturisation.

Companies in the News

Steel Company of Wales

Investment in sheet-steel production continues to prove well worthwhile. In the twelve months ended 28 September, 1958, the Steel Company of Wales earned a trading profit of £22 million on a turnover of £113 million. The corresponding figures for 1957 were £19 million and £109 million. This performance, states Mr. Harald Peake, was not unsatisfactory " in a year during which the iron and steel industries of both the United States of America and of the United Kingdom have experienced a marked depression." The improvement has been made possible " by a very active selling organisation and by the outstanding achievements in the export market of our many customers in the motor, engineering, electrical and packaging industries."

Mr. Peake gave most interesting information on the company's progress. Expenditure on capital account during the year amounted to £22·5 million, most of which was in connection with the company's third development plan.

This development plant should be completed by next June when the main producing units are expected to be in operation. Some £21·5 million of the estimated total expenditure of £52·5 million will be paid out during the current year, and an ingot production rate of 3 million tons per annum is hoped for early in 1960.

On the company's prospects, Mr. Peake was confident. The current year opened with full-time working in all divisions and the order book for the first quarter of 1959 " promises well." In the second and third quarters, production capacity is expected to increase as a result of additional units coming into operation. This should enable the company to achieve the greater trading surplus required to meet the interest on the heavy capital cost of the third development plan. He underlined the importance of exports, and spoke strongly against renationalisation, on the grounds that " it would be difficult to maintain, much less to expand, sales in the export market in competition with countries whose iron and steel industries are not nationalised." Mr. Peake's many arguments against nationalised industry are hard to counter.

Transducers Translated

The agreement signed in 1957 between the Consolidated Electrodynamic Corporation, Pasadena, California, and the Solartron Electronic Group has been extended to include a range of pressure pickups developed for the aircraft industry. This action supplements the agreement to manufacture and sell " Datatape " magnetic tape recorders for data processing.

The CEC pickups are designed for the precise measurement of pressure, where size is an important factor and pressure changes are too rapid for observation and measurement by conventional devices, and where temperature changes would cause interference. Temperature compensated from − 350° F to + 650° F, they are data processing transducers which convert electrical pressures into electrical signals to be fed, eventually, into data processing equipment. They have many industrial applications but are particularly suitable for nucleonic work because they are capable of operating under conditions of medium-intensity gamma radiation for long periods without loss of performance.

Shuffle and Redeal

Following the integration of the Witton and Erith works of the General Electric Company within a single engineering group, a number of new appointments have been announced. The new group will be under the control of Mr. A. L. G. Lindley, who is assistant managing director of GEC. At Witton, Mr. T. H. Kelsey has been appointed assistant general manager and Mr. J. W. Laing chief engineer. Mr. Laing will be responsible for the engineering and sales activities of the rotating machine, switchgear, transformer, rectifier and traction divisions. Mr. J. S. Cliff and Mr. E. Gallizia have been appointed assistant chief engineers, and Mr. A. E. Taylor engineering liaison officer between the home branches and Witton and Erith.

At the Erith Engineering Works, where Dr. K. J. Wootton was recently appointed manager, atomic energy division, Mr. B. S. Pelton is appointed manager, general engineering division (which includes mining and materials handling equipment), and D. M. Smith, manager of the power plant division. At Head Office in Kingsway, Mr. C. J. O. Garrard becomes manager, engineering department, and will be responsible, *inter alia*, for the company's engineering activities in Europe. Mr. E. W. Molesworth succeeds Mr. Kelsey as personal assistant to Mr. Lindley.

Under New Management

Major changes have been made in the leadership of companies, many of them effective at the year's end. William Doxford and Sons have a new managing director, Mr. J. G. Hugall. Dr. J. Ramsey Gebbie relinquished this post but continues as chairman of the holding company and of the two main subsidiaries, Wm. Doxford and Sons (Shipbuilders) and Wm. Doxford and Sons (Engineers). Mr. W. H. Purdie has resigned from the board. The managing directors of the shipbuilding and engineering companies, Mr. Clement Stephenson and Mr. Robert Atkinson, have joined the board of one another's companies and also the board of the holding company. Mr. Atkinson joined Doxford's only recently from Hamworthy Engineering where he was managing director.

The British Thomson-Houston Company have made recent changes in their directorate. Mr. L. Drucquer, who has recently been appointed as chairman of AEI Divisional Management Company and divisional director and general manager of the AEI Heavy Plant Division, has relinquished his appointment to the BTH board. Mr. H. R. Hopkirk, director and chief mechanical engineer of BTH retired after 43 years with the company. Mr. H. S. Holbrook, BTH consulting engineer on transformers also retired, after 48 years' service. Other retirements included Mr. S. A. Couling of the chief engineer's department (formerly chief gear engineer) and Mr. H. Dreghorn, manager-manufacturing, Rugby Works and sub-factories. Mr. Couling and Mr. Dreghorn respectively totalled 33 and 44 years of service with the company.

Construction Firm

The construction industries continue to be fully occupied and appear unlikely to experience a recession. For those, like Crowley, Russell and Company, who have concentrated on civil engineering and industrial building, the programme has provided a good new outlet. In his annual statement to shareholders the company's chairman, Mr. John Crowley, remarked that the volume of civil engineering and industrial building continued to be limited during the year ended at 31 March, particularly in Scotland. He was able to report, however, that (when he spoke) the volume of work in hand was "almost the same " as a year ago. He found indications of " an increasing development of new road construction " encouraging, but expected conditions to be highly competitive " until this new work gets under way."

The latest statistics on constructional activity support Mr. Crowley's confident outlook. The fall in orders received this year is not affecting output and the backlog of work is still high. There have been substantial increases in private house building and in public works which have offset declines in other sectors. The value of work (other than housing) done for the public authorities amounted to £108 million in the third quarter of this year, compared to £96 million in the corresponding period of 1957. Moreover, new orders are up—by 8 per cent during the first half of 1958. In housing the major change has been the increase in the volume of private housing work done. The fall in orders received in recent months may well be arrested by the relaxations of Government restrictions on credit and by their cheaper money policy.

Perhaps the most encouraging sign is the expectations of the manufacturers of contractors' plant for increased orders at home—despite the cut in opencast coal mining. The road programme is a powerful stimulus all round.

Reynolds News

The dramatic entry recently of the Reynolds Metals Company as a likely buyer of British Aluminium's shares has attracted attention to the company's world-wide activities. Their British partners, Tube Investments, have just circulated the " year-end review and outlook statement " by Reynolds's president. In it Mr. R. S. Reynolds, Jnr., discusses the prospects of the aluminium industry and the place his company occupy in it. They are the second largest producers in the United States, with total sales in 1958 at $446 million—about the same level as in 1957. Current capacity in the United States for primary production of aluminium is 2·15 million tons a year. Current expansion projects will raise this to 2·45 million tons a year by the end of 1959. When Reynolds' new 100,000 ton plant at Massena, NY, is completed, their primary capacity will be raised to 701,000 tons, nearly 29 per cent of the country's total.

Mr. Reynolds's review of prospects for the industry is markedly optimistic. " We look for increased sales volume in 1959," due partly to the fact that demand for aluminium began its recovery much earlier than the general economy, and partly to the successes encountered in the intensive search for new uses for the metal, and increases in others. Among increased users is the car industry, expected to consume 58 lb of aluminium per car in 1959, compared to 52 lb in 1958, and car output is confidently expected to be one million more than last year.

There were important new developments in the applications of aluminium for ships, tanks, electric substations, railroad equipment and other big uses. " This " said Mr. Reynolds, " marks the beginning of a vital new phase in the growth of our industry, which until recent years concentrated mostly on broadening applications in the lighter gauge ranges." There is certainly nothing anaemic about Reynolds Metals.

Aluminium into Tubes

After a number of highly active days on the Stock Exchange, Reynolds Metals and Tube Investments secured control of the British Aluminium Company. The Treasury has still to give its consent, but that is not expected to be an obstacle.

The whole incident leaves behind it an unsatisfactory flavour of ineptness and bitterness. The initial moves of the board of British Aluminium in making a contract with Alcoa in the United States on authorised but un-issued shares without informing existing shareholders caused a good deal of adverse comment in the City, but financial institutions there just about balanced the account with their performance when they took sides in the dispute at a later stage.

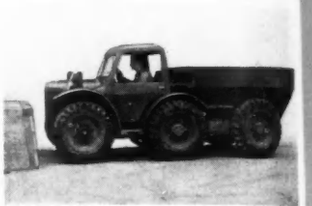
Hindsight is always cheap, but, from British Aluminium's point of view, the efforts made at the last minute to form a consortium to make the Alcoa contract more acceptable to shareholders suggests that the former might have raised more money in this country than it thought possible if it had tried harder and with more imagination. It remains to be seen if the outcome means a more rationalised and efficient aluminium industry in this country—and this is in the end the main criterion by which the manoeuvrings of the last few weeks will be judged.

Automobile Engineering

UP AND OVER

The Lorry with the Lifting Nose

The Metrac is designed for the roughest country; it can negotiate ditches or walls.



THE Metrac is a new kind of cross-country vehicle built in Switzerland which can do practically everything other cross-country vehicles can do and a few other things besides, including climbing over walls. All six wheels are driven by an engine at the front. Front and rear wheels are carried on hollow swinging arms pivoted on the central axle. The hollow arms contain the chains which drive the front and rear wheels. In addition, the load-carrying rear portion can swing about the central axle.

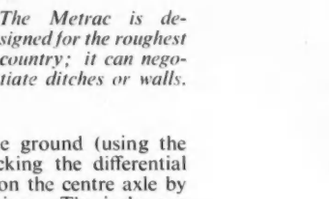
The swinging arms are linked to the body by vertical hydraulic jacks which are normally left "free" to allow wheel movement on uneven ground. Linking the front and rear portions are horizontal jacks which can be retracted to give the vehicle an inverted V-formation, or extended to make it arch its back. They can also be locked to give it a rigid wheelbase and so simplify the crossing of narrow ditches.

The engine, (in the prototype a six-cylinder Chevrolet), gearbox and differential are mounted on a sub-frame. The drive is through a four-speed gearbox to the differential on the centre axle and then by chains to front and rear wheels. There is also a reduction gear for cross-country work. The differential can be can be locked by the driver.

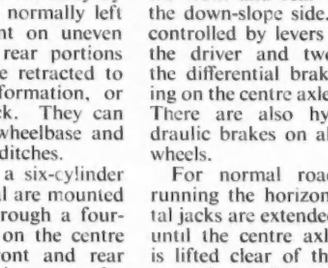
The front wheels are steered by long drag links lying parallel with the swinging arms and connected to a transverse linkage near the centre axle so that any vertical wheel movements do not affect steering angle.

The vehicle can be turned in its own length by lifting front or rear wheels from the ground (using the horizontal jacks), unlocking the differential and braking one wheel on the centre axle by a lever alongside the driver. The jacks can be used to hold it rigid while crossing narrow ditches, while it can descend into deep wide ditches and climb out again by reversing the wall-climbing routine. Traversing steep slopes is a hazardous operation in which a vehicle can easily roll over sideways but the Metrac can do it on an even keel by extending the front and rear wheel (vertical) jacks on the down-slope side. Hydraulic services are controlled by levers on the panel in front of the driver and two vertical levers control the differential braking on the centre axle. There are also hydraulic brakes on all wheels.

For normal road running the horizontal jacks are extended until the centre axle is lifted clear of the ground and the vehicle travels on the other four. Suspension is then by volute springs incorporated in the hydraulic jacks, but the spring rate is high and wheel movement is restricted in order to ensure sufficient lateral stability.

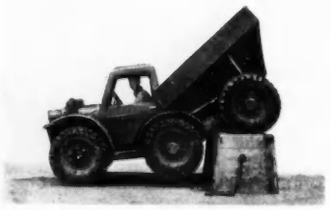


The vehicle is built round the central axle which serves as an axis of rotation for the two halves of the vehicle and for the four swinging arms carrying front and rear wheels. The horizontal jacks enable it to arch its back and lift the centre axle or assume a V form, lifting front or rear ends according to weight distribution.

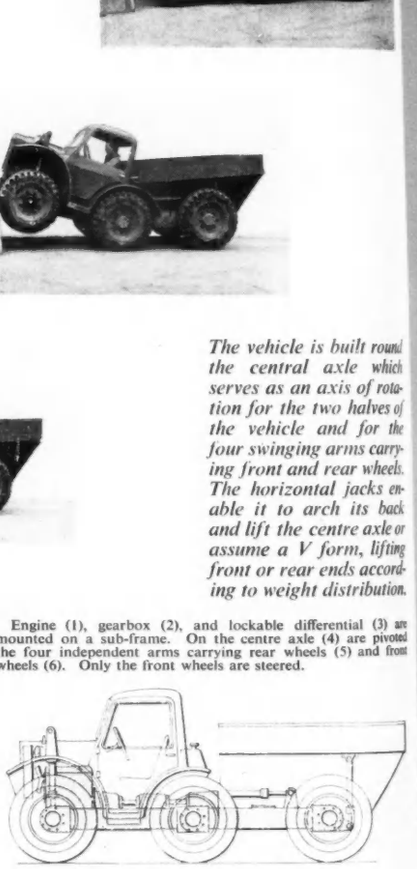


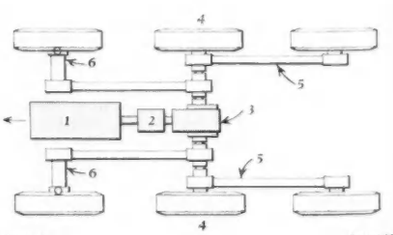
The series of photographs shows the vehicle climbing over a wall while loaded with 1½ metric tons.

The driver approaches the wall and lifts the front of the vehicle by the horizontal jacks. The wheels start climbing, helped by a push from the rear. The front axle is steadily pushed to the top of the wall by thrust of rear wheels and the truck arches its back again by using the horizontal jacks, lifting the middle wheels off the ground. Next the truck moves forward and the rotation of centre wheels aided by the weight of the engine lifts the rear end off the ground. With the rear end raised on to the wall, the front and middle wheels descend to the ground. A similar procedure is followed when crossing deep and wide ditches. The ability to lift the front of the vehicle prevents it from digging into the opposite bank. The vertical jacks also enable any wheel to be lifted up.



Engine (1), gearbox (2), and lockable differential (3) are mounted on a sub-frame. On the centre axle (4) are pivoted the four independent arms carrying rear wheels (5) and front wheels (6). Only the front wheels are steered.





(5901 1) "ENGINEERING"

The vehicle is manufactured by Ernst Meili, Hochstrasse 129, Schaffhausen, and the illustrations are reproduced by courtesy of Automobil-Revue, Berne.

The Human Element

Learning to Live with Oil

This country is in the throes of a revolution in house heating methods. The rate at which central heating installations are being carried out probably exceeds 25,000 a year and is rising fast. The major oil companies have embarked on a powerful advertising campaign to popularise oil-fired central heating. The makers of equipment, leaders among whom include Sigmund Pumps, Hurseal and Nu-Way Heating Plants, are also making great efforts to popularise the system and to teach the trade how to install the equipment simply and effectively.

The National Industrial Fuel Efficiency Service are holding a three-day course on oil-firing, in mid-January (filled very soon after it was announced), and have just announced their decision to hold another in mid-April. It is be held at NIFES' offices in Reading (Ailex House, Kings Road) and will cost six guineas, exclusive of hotel accommodation. Application forms and the course syllabus can be obtained from NIFES' London office, at 71 Grosvenor Street, W.1. In domestic affairs, oil went out with the oil lamp—but now it's back in strength.

Mr. Mayne Accuses

The dynamic general secretary of the Institution of Professional Civil Servants, Mr. Stanley Mayne, is in full cry in this month's *State Service*. The Government are given a tousing. The Ministry of Transport, argues Mr. Mayne, are guilty of startling incompetence (or is it bad faith?) in dealing with a pay claim submitted by the Institution on behalf of air traffic control officers.

The facts as given in *State Service* are as follows: claim submitted in October, 1957; rejected in August, 1958—reason: the officers' pay "compared favourably" with that of people engaged on similar work elsewhere. Asked who these people were, the Ministry were unable to say and (in December) were proposing to make some inquiries at private flying grounds and from the Atomic Energy Authority and Central Electricity Generating Board (why from the UKAEA and CEGB is not clear). Mr. Mayne comments aggressively: "What does this mean but a deliberate determination to do nothing at all on a pay claim designed in a reasoned manner and put up with a considerable amount of evidence in support of the claim? It is this sort of thing that leads to anger against all established forms of negotiation and a complete disbelief in their reality."

Strong language is used also in the journal's leading article on the recent Treasury offer to Civil Service clerks. The service department is described as showing "complete unwillingness to enter into serious negotiations." Mr. Mayne describes as "very worrying" the assertion of the Civil Service Clerical Association that the offer bears little relation to the position revealed by a report of the Pay Research Unit on the pay of comparable workers elsewhere. A leading article comments that the Civil Service had been prepared to give the research system a fair trial and had hoped that it would help negotiators to reach agreement without constant recourse to the arbitration tribunal. The virtual rejection of the clerical claim might lead some civil servants to press for more satisfactory means than the Pay Research Unit for settling their claims.

Bonus for Building

Working out bonus schemes for building industry operatives involves the basic difficulty that building workers are in gangs which change their composition from site to site and that, in contractual work of this kind, there is only limited continuity. A report has now been published called *Incentives in the Building Industry* (National Building Studies, Special Report No. 28).

The report makes a large number of suggestions about how to run incentive schemes and these consist basically of the application of established work-study principles in the field of bonus work to the special conditions of the building industry.

Special emphasis is laid upon using incentive payments on jobs which have visual stages of work, last for about one week, and are continuous without hold-ups from other jobs. There should be flexibility in targets, in the percentage of the "saving" paid as bonus, and in the method of share-out among operatives in gangs. Quality of work should be safeguarded by better supervision and by keeping site staff independent of the bonus.

If these ideas are adopted in the industry, there will have to be much greater emphasis on quality of management and on good labour relations. Such schemes will not work properly unless cost information is readily available, supervision is of a high order and realistic targets are fixed. The union side will have to be handled with care, for there are some principles to be agreed in this kind of arrangement which may sound unusual to the men's representatives, and novelty is a rich diet for district organisers.

Petrified Error

It is over 800 years since the builders of the leaning tower of Pisa discovered that the tower was sinking to one side as they erected it, and hastened to add to it what would perhaps be called today a built-in stabiliser. The medieval surveyors had made a mistake, but their error was discovered in time, and they provided the world with an architectural oddity and the schoolboy with an object lesson in the law of gravity and the vertical pull of the earth.

In this way a medieval howler became a tourist attraction to Italy. More recently, the building has started to sink and modern knowledge has been brought in to preserve the tower. Professor Cebertowitz, of the Building Institute of the Warsaw Academy of Sciences, has been called in to try out the "electropetrification" process. This makes use of the principles of cataphoresis and osmosis, and involves introducing alkaline silicates into the soil and passing an electric current through it. The process has been fairly widely used both in Europe and in the United States. It was also used in building the Volga-Don Canal.

Some of us make mistakes and are remembered for them in a limited circle. Some make mistakes and by fortunate coincidences pull off some brilliant stroke in consequence. There are thousands of architectural "mistakes" throughout the world but few will get the expensive treatment for perpetuity that has gone into the tower at Pisa. Few would lobby to "petrify" the Albert Memorial or St. Pancras station, should they begin to list.

Retire for Advice

Last summer the Regional Advisory Council for Technical Education (London and Home Counties) began its second decade of work. Certain changes in the Council's constitution had been under consideration for a year or so and these were written into the constitution last May.

The main alterations have been to reduce the number of advisory committees, but to raise the industrial representation on those which remain, and to define more closely the field of work of the Council. It was also agreed that the advisory committees should play a greater part in the work of the Council. The net result of the changes has therefore been to bring the industrial influence closer to the Council's work. This is one more example of industry and public administration, including voluntary service, moving closer together in matters of training for industry.

The trend is wholly to be welcomed but it has to be recognised that it creates work for people who are already fully occupied. Industrial representation is usually secured by the appointment of staff from such organisations as the Federation of British Industries, from trade associations and from the Trades Union Congress, but there is a limit to the amount of experienced staff available for this kind of work. It is noticeable how certain retired top executives in industry have thrown their energies into advisory work on technical education. It is worth considering whether more of these people can be encouraged to take part. They often have the time as well as the experience.

Visiting Team

A team of miners from Yugoslavia is here to learn as much as can be crammed into three months about coal getting and coal treatment methods. Their visit, which is financed by the United States Third Country Training Scheme, is keyed to Yugoslavia's plan for an increase of 40 per cent in coal production by 1961, and special emphasis will be placed on mechanisation.

The four members of the team are all in their thirties, and well qualified mining engineers. They are currently being given a one-month refresher course in English by Davies's School of English in London before they begin their tour on 1 February. They will visit 30 collieries in six divisions of the NCB, and 16 factories, research units and rescue centres. Included among the latter are manufacturers of modern equipment.

It is encouraging to find other countries selecting Britain as a place of learning in methods of mining operations. This kind of development should be widely welcomed, since it teaches about British products as well as about British methods.

Executive Sweeter

Wives may not like at all an article in the current issue (December-January) of the du Pont Magazine which describes a trend to make executives' offices homely, "for visitors and residents alike." It is only a short step to an adjoining bedroom, television set, drug cupboard and breakfast room. Already the executive suite of Mr. B. has taken on a pleasant lived-in look. Mr. B. is a textile company president who has recently moved his firm into new quarters.

His secretary describes her boss's new freedom as follows: "Mr. B. works a full day and moves around a lot in the office. In the morning he and his visitors often use the big chairs and sofa. He finds the coffee table too low to work at, though, so pretty soon I see them drift over to the big table. When more than four people are involved, it becomes a meeting and they usually go next door to the conference room."

The article is informative on trends of executive thoughts and tactics. Big desks are out of fashion—"of moderate size with light graceful lines." "to work through rather than at." Conference tables are popular. No U-class executive will contemplate "any furniture that belongs to an earlier day." Depressing perhaps but doubtless realistic. Much worse for wives than for husbands. Plenty of business for office equipment makers. Sweeter executives in a home from home sweet home.

Special Article

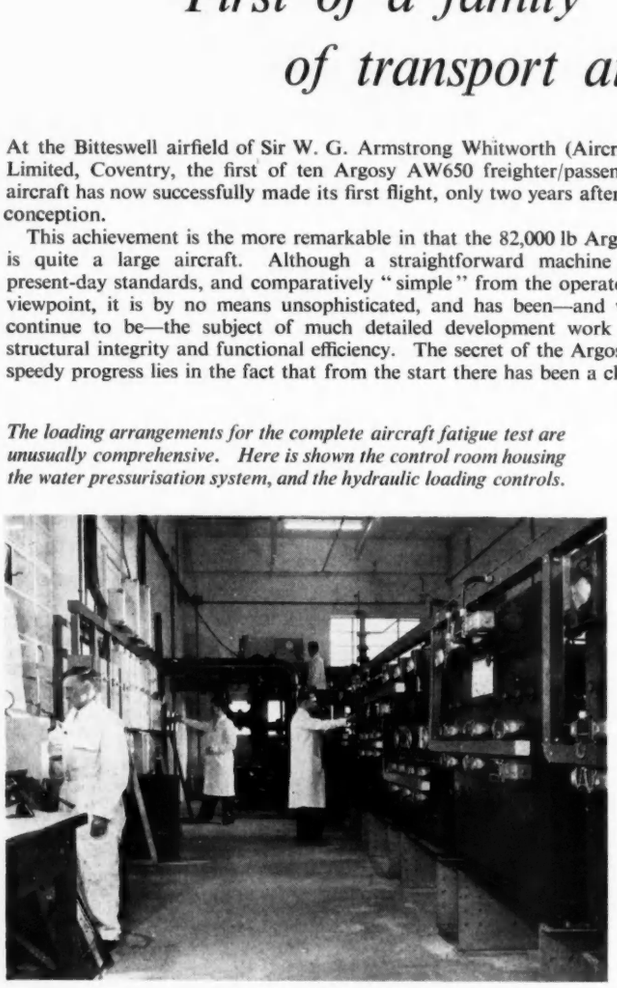
ARGOSY

First of a family of transport aircraft

At the Bitteswell airfield of Sir W. G. Armstrong Whitworth (Aircraft) Limited, Coventry, the first of ten Argosy AW650 freighter/passenger aircraft has now successfully made its first flight, only two years after its conception.

This achievement is the more remarkable in that the 82,000 lb Argosy is quite a large aircraft. Although a straightforward machine by present-day standards, and comparatively "simple" from the operator's viewpoint, it is by no means unsophisticated, and has been—and will continue to be—the subject of much detailed development work on structural integrity and functional efficiency. The secret of the Argosy's speedy progress lies in the fact that from the start there has been a close tie-up and effective feedback between the design, development and production departments.

The loading arrangements for the complete aircraft fatigue test are unusually comprehensive. Here is shown the control room housing the water pressurisation system, and the hydraulic loading controls.



The AW650 Argosy is the first of a projected family of transport aircraft. The philosophy underlying its design is that of a specialised civil freighter which can be converted easily (on the production line) for military use. Two days before the flight of the civil prototype, it was officially announced that a military version of the Argosy had been ordered for RAF Transport Command. The Argosy is powered by four engines of proved airline reliability—2,100 h.p. Rolls-Royce Dart turbo-props. For ease of freight handling, the hold has a low-level floor for direct loading from lorries, and in the civil versions large full-width freight doors are fitted at each end of the fuselage. To allow for ready conversion to the military type of freight door with integral loading ramp and provision for stores-dropping during flight, the tail unit is mounted on twin booms. (The military freighter is designated AW660.) Because the aircraft is designed to cruise at high altitude, the fuselage is pressurised—whether for freight or passenger traffic, civil or military operations.

It occurred to Armstrong Whitworth that some operators might prefer a twin Tyne-powered freighter (AW651, civil and 661 military) to the four Dart version (for greater economy in maintenance and operation). The inner engines were therefore spaced to give adequate clearance for the larger propellers required for the 4,985 h.p. Tyne turboprops. This has also made it possible to put forward a proposal for a wide-fuselage unpressurised variant (AW670) suitable for short-range car-ferry duties, carrying six cars, two abreast, in the hold, with the passengers on an upper deck. An alternative version of the 670, the AW671 Airbus, is also envisaged, to carry 126 passengers over short stages of about 200 mile lengths. Armstrong Whitworth believe that such an aircraft could be operated on the lines of a frequent bus service, at fares competitive with those of rail and bus travel. Jersey Airlines is one of the operators showing interest in this version.

Apart from the 650 Argosy, however, all these variants are as yet only on paper. The Argosy itself is intended for medium-range freighting and passenger-carrying duties; cruising at nearly 300 m.p.h., it can carry a payload of 27,000 lb over a range of 800 statute miles (no reserves allowed); restricting the payload to 9,400 lb, maximum range (no reserves) is about 2,800 statute miles.

Turning now to a brief consideration of some of the engineering features of the Argosy: it is interesting to note that Armstrong Whitworth are among the most fatigue-conscious of Britain's aircraft constructors. Long before the Comet disasters in 1954 called attention to the problem of pressure-cabin fatigue, Armstrong Whitworth had realised that repeated loadings to high differential pressures constituted a potential hazard; and in 1948, in fact, they installed a water tank in which the Apollo fuselage was subjected to an intensive programme of repeated pressure cycles before the aircraft was ever flown with cabin pressurisation.

For fatigue testing the Argosy structure, they have installed two water tanks. One is intended for tests on the fuselage only, and will be used for proving the static strength of the fuselage, for crack-propagation investigations and "fail-safe" proving. The other tank is intended for fatigue tests on the complete airframe and has apertures in the tank walls through which the wings pass, sealed by U-seals bolted to the tank and bonded to the wings. Either tank may be used as a reservoir for the other, the wing cut-outs in the second tank being then blanked off. Both tanks are served by a control building in which are housed the water system controls, the fatigue hydraulic-loading system, load measuring indicators, fatigue programme unit, flight cycle recorder and, on the floor above, strain-gauge preparation and recording rooms.

The loading arrangements for the complete aircraft fatigue test are unusually comprehensive, provision being made for wing loads, flap loads on the rear wing spar, engine torque and nodding loads on the mountings, tailplane loads, undercarriage and nosewheel loads, fin loads, fuselage reaction and pressurisation loads. The loading cycle, representing a 500 n. mile stage, will simulate conditions during taxi-ing and take-off, climb to 25,000 ft, cruising for 70 minutes, descent, circuits, landing and taxi-ing. During the flight condition, representative gust loads will be applied to the wing, these being preselected on the programme unit. This complete test is, of course, only the culmination of a detailed strength testing programme on the individual structural members and assemblies. One interesting example of the practical approach for assessing the relative merits of riveted and Redux-bonded floor panels: specimens of each were installed at the main entrance to the Whitley drawing office, where pedestrian traffic is heavy! After 40 days of service with about 1,000 pedestrian movements per day, inspection revealed that, beyond all doubt, the bonded panels were superior in wear.

Armstrong Whitworth are one of the members of the Hawker Siddeley Group. To speed production of the Argosy, another group member—A. V. Roe and Company Limited, Manchester—are sub-contractors for

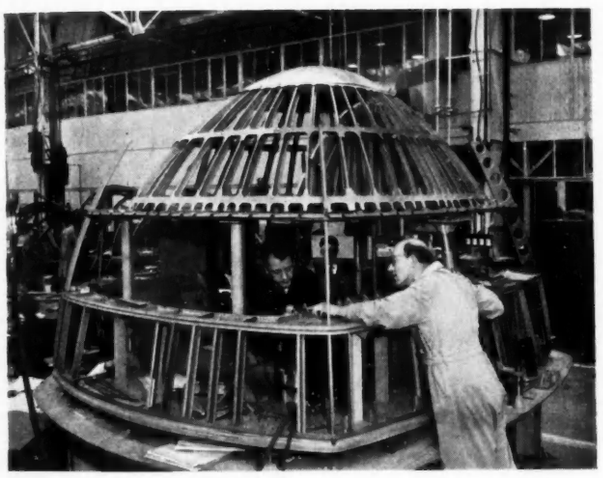
the wing and the Gloster Aircraft Company Limited have designed the tail units. Much of the tooling for the Avro Shackleton wing is used for the two-spar wing of the Argosy—but the Argosy wing has been designed for a very much longer fatigue life, with stronger centre-section booms and great attention to the elimination of stress raisers by a high degree of surface finish. The makers are currently predicting a minimum safe life of 30,000 hours for the wing.

Other than the wing, the structure is designed to be " fail-safe," with duplicated load paths, low stress levels and " crack stoppers." In the fuselage and tail booms, the attachment of the transverse I-section frames to the skin is unbroken, and they are backed by circumferential straps through which the closely-spaced intercostal stringers are riveted. The inner flanges of the stringers are, however, continuous through piercings in the frame web. At all door and window openings, bonded doubler plates avoid high concentrations of stress. Two robust double frames carry the fuselage loads into the centre-section spars, which extend across the fuselage.

As already noted, Armstrong Whitworth are using Redux bonding in various structural applications, and an interesting approach is evident in some of the design details—for example, the main spar joint fittings, instead of the usual machined forging, are built-up fittings comprising Redux-bonded laminated plates. Similarly in some of the main structural members, what would conventionally be an extruded section has been replaced by a " nest " of Redux-bonded angles. Such techniques are not only economical and time-saving but also eliminate the disadvantages springing from variations in grain size which can occur in extrusions and forgings and which must be removed in the machining process.

Preliminary inspection of the fuselage after 2,000 repeated pressure cycles in the water tank.

The freight doors, one of which is seen under construction, are side-hinged dome-shaped structures.



One-piece side-hinged cargo hold doors have been chosen for strength and rigidity and because they reduce sealing problems, compared with double doors. The design of the hinges avoids distortion consequent on sagging when the door is unlocked. The main frames of the dome-shaped door structures are bonded honeycomb sandwich panels; the front door incorporates a reverse-curvature pressure dome, forward of which is located the cloud-collision warning radome.

Taking a quick look at the main aircraft systems: for reliability and rugged service, the main flying controls, fitted with conventional spring tabs, are manually operated. Large-chord slotted flaps are hydraulically operated, as is also the retractable undercarriage. The Dowty main units of the latter have Dunlop twin wheels (preferred to bogies by airlines operating where manoeuvring space is limited), and are fitted with Maxaret anti-skid units. Also operated by the engine-driven hydraulic system are the nose-wheel steering and duplicated wheel brakes.

Cabin pressurisation to a maximum differential pressure of 5·5 lb per sq. in is supplied by three engine-driven Godfrey blowers. The air conditioning equipment is installed in a compartment aft of the flight deck, above the hold—and is accessible during flight for servicing, as is also the master distribution panel for the 24 volt direct current electrical system (a split bus-bar system supplied by four engine-driven 6 kW generators running in parallel). Inverters supply a.c. power for radio and radar, and four 22 kVA alternators supply the electric de-icing units for propellers and tail surfaces, engine and oil-cooler air intakes and the windscreen heating. The wing leading edge de-icing duct is fed with ram air heated in an exhaust gas heat exchanger. 3,300 Imperial gallons of fuel are carried in ten bag tanks between the wing spars, and can be pressure-refuelled at a rate of 150 gallons per minute.

All ten of the Argosies are expected to be off the line and in the air before the end of next year, and a second production line is being set up for the AW660 military freighter. The first three aircraft will be devoted to certification flying—and Armstrong Whitworth hope to qualify for both British and American airworthiness certificates by mid-1960. Meanwhile, an intensive propaganda campaign must be launched by the Hawker Siddeley sales engineers to ensure that industry, as well as the airlines, are awakened to the potentialities of air freighting.

In the article " First Vanguard off the Line " (ENGNG, 2 Jan., p. 14) the powers for the Rolls-Royce Tyne should have read: Stage I Tyne, 4,985 e.h.p., Stage II Tyne, 5,525 e.h.p.

The first flight of the Argosy on 8 January. The aircraft was in the air for about an hour.

Management

WHAT THE FUTURE HOLDS *for* TEXTILE MACHINERY

In the first report of this series, on page 6 of our issue of 2 January, consideration was given to the effects of exports, raw materials, and wages and working hours, on industry as a whole. The second review, on page 40 of last week's issue, examined conditions in particular industries:—aircraft, shipbuilding and motor vehicles. This week's report is concerned with textile machinery, and locomotives and rolling stock. Reports on other industries will be published in succeeding issues of ENGINEERING.

The textile machinery industry had another disappointing year in 1958, though there were some bright features and experience varied a good deal from one manufacturer to another. In general, however, depressed conditions in the British textile industries, coupled with the restrictions on credit facilities, tended to reduce home orders and the export market also proved very difficult, due rather to currency difficulties in the principal markets than to intensified competition from foreign textile machinery manufacturers.

As from the end of 1957, the Board of Trade have discontinued the publication of statistics respecting deliveries of textile machinery and it is not possible, therefore, to include the usual diagram showing their trend. In each of the three years 1955, 1956 and 1957, however, deliveries for export accounted for just over 50 per cent of total deliveries, and the broad picture of production was that the increasing outputs of hosiery, knitting, lace and embroidery machinery was just sufficient to offset declining deliveries of other types of textile machinery. The export figures shown in the attached Table suggest that a similar trend continued in 1958 in spite of the total exports having fallen to about £39·7 million, compared with £43·2 million in 1957, and to £45 million in 1956.

The only category to show an increase in 1958 was hosiery and other knitting machinery which rose from £7·6 million to £8·4 million. In fact, British manufacturers of hosiery and knitting machinery have achieved an increase in exports in each of the past five years. The export ratio for the industry is exceptionally high, reaching to 74 per cent in 1957, and the strength of British manufacturers is shown by the fact that they supply the bulk of United States requirements, in addition to selling about 60 per cent of their total exports to OEEC countries. Nevertheless, the industry is one which may be seriously affected by a failure to establish a European Free Trade Area, particularly in view of the rapid rehabilitation of the German industry much of which industry was formerly in the Eastern zone.

The main reason for the fall in exports of other types of textile machinery was the reduced demand from India which, for some years, has been the largest individual market for British textile machinery. Actually, the decline in exports to India amounted to some £3·2 million, an amount which was only very slightly less than the fall in total exports. There were also serious falls in the exports to Pakistan, "other Commonwealth countries," the United States, Belgium and France, but these were largely offset by increased exports to Australia, Western Germany, Japan and "other foreign countries." These increases, achieved in a difficult year, together with the fact that the decline in exports to India has been to a large extent due to that country's lack of foreign exchange, suggest that the British textile machinery industry is in a relatively strong competitive position and may eventually be able to reverse the declining trend of exports, though possibly not during the current twelve months.

The past year saw some revival in the demand from the Middle East, which had declined following the Suez crisis. Then, in September, Tweedales and Smalley Limited announced that a substantial order from Persia had enabled them to resume full time working in all departments, while Platt Brothers (Sales) Limited were able to resume deliveries to Egypt. Total exports to Egypt are understood to have been of the order of £1 million in 1958, compared with a negligible amount during the previous year.

Exports to the Soviet Union, which was formerly an important market for British textile machinery, have been disappointing during the past few years, having fallen from £2·1 million in 1956 to £1·1 million in 1958. There is, however, still a large potential market for certain types of textile machinery in the Soviet Union and the State Planning Commission sent a delegation to the International Textile Machinery and Accessories Exhibition at Manchester in October, 1958. A month earlier it had been announced that Technopromimport had placed a contract with Courtaulds Limited for the supply of machinery for the production of cellulose-acetate yarn. Although much of the plant will be supplied by Courtaulds themselves, the contract also included substantial orders for twisting and doubling machinery. One of the Russian delegates to the International Exhibition said that they were particularly interested in machinery for spinning artificial and synthetic fibres. The delegate went on to say that the textile industry was growing so rapidly in Russia that the Russian textile machinery industry was unable to meet the demands upon it.

As the industrialisation of China proceeds, there is also likely to be a growing demand for the more advanced types of textile machinery from that country. Early in 1958, it was announced that British manufacturers had received contracts valued at about £700,000 from the Chinese textile machinery mission. At the same time, however, Japanese textile machinery makers were complaining of Chinese competition in South East Asia. A number of the smaller Indian mills were said to be installing cheap Chinese machinery, and both India and the South East Asian countries were prepared to buy textile machinery only on deferred terms spread over a long period. The Communist countries, particularly China and East Germany, were apparently willing to accept more onerous credit terms than were manufacturers in other countries.

It is doubtful whether British manufacturers can, or should attempt to compete with China in the supply of the simpler and cheaper types of textile machinery. As the industrialisation of Eastern countries proceeds, however, and the standard of living rises, there is likely to be an increasing demand for more complex types of

TABLE.—*United Kingdom: Exports of Textile Machinery by Main Machinery Groups*

	Quantities (1,000 cwt)			Value (£1,000)		
	1956	1957	1958*	1956	1957	1958*
New:						
For making synthetic fibres	23	20	11	1,004	778	589
For spinning and twisting and preparatory processes	881	742	600	22,214	19,967	17,443
For preparatory to weaving but subsequent to spinning and twisting	54	62	56	1,715	2,197	2,148
Looms and other weaving machinery	266	219	171	5,074	4,510	4,269
Bleaching, dyeing, printing and other finishing	118	89	76	3,216	2,663	2,483
Hosiery and other knitting	56	66	67	5,978	7,583	8,403
All other textile machinery	66	65	49	2,406	2,351	1,856
Accessories separately consigned:						
Bobbins	7	7	7	289	271	332
Card clothing	25	22	19	1,405	1,375	1,125
Shuttles	5	4	3	235	198	169
Other	25	19	11	599	534	284
Second-hand	81	84	59	850	790	623
Total	1,607	1,399	1,129	44,985	43,217	39,724
Of which exported to:						
Union of South Africa	25	36	28	848	1,025	983
India	404	267	128	9,857	6,942	3,735
Pakistan	73	84	33	1,489	2,040	776
Australia	46	92	102	1,546	3,181	3,723
Canada	26	27	16	1,156	1,297	903
Other Commonwealth countries	57	63	35	1,342	1,549	1,097
Irish Republic	35	36	27	736	640	645
Soviet Union	82	41	35	2,100	1,426	1,059
Western Germany	56	61	54	2,263	2,531	3,133
Netherlands	42	42	31	1,130	1,235	1,125
Belgium	49	49	32	1,323	1,479	1,076
France	65	77	42	2,490	2,941	1,977
Portugal	37	29	26	801	787	796
Italy	31	46	41	1,419	1,571	1,537
Other West European countries	80	61	46	2,939	2,548	2,119
Japan	10	22	28	478	872	1,432
Philippine Republic	33	45	41	757	1,134	1,100
United States of America	59	43	19	2,317	2,086	1,109
Mexico	67	59	27	1,690	1,482	1,087
Other foreign countries	330	221	338	8,308	6,447	10,312

* Nine months annual rate.

machinery, and it is important that British manufacturers should be in a position to secure this trade. The British industry is often criticised for a lack of initiative in exploiting new developments, but, in fact, considerable technical progress has taken place in recent years. An important development during 1958 was the completion of mill trials on the Shirley loom for continuous filament yarns and the announcement by Wilson and Longbottom Limited that the loom was in commercial production. This loom was developed over several years by the British Cotton Industry Research Association (the Shirley Institute) and its design took into account the wide experience of the Association in relation to cloth faults and their cause. The loom is claimed to be capable of producing a very wide range of cloths of all weights and thicknesses using continuous filament man-made fibres, including glass fibre.

The fact that there have not been many revolutionary changes in the design of textile machinery in recent years tends to obscure the amount of development work which has been done by the industry. Dr. D. W. Hill, Director of Research at the British Cotton Industry Research Association, recently pointed out that the textile industry was the first to benefit from the Industrial Revolution and that, in the early stages, the rate of development was such as to put a high premium on invention. Accordingly, the level of engineering attainment in the textile industry was in advance of that in most, if not all, other industries. He argued that the ingenuity of the early inventor of textile machinery was such that it largely prevented the industry from subsequently departing from traditional styles of machinery. For many years, the ring frame was the only departure from the principle that textile machinery was designed to copy mechanically what had previously been done by hand.

Dr. Hill went on to say that the trends in the engineering industries as a whole and the multiplication of raw materials used in the textile industries were causing a re-thinking of traditional textile processes which was now influencing the design of textile machinery. The two main consequences of this new trend are, to some extent, contradictory. There is a demand for a higher standard of precision in textile machinery, arising largely from the use of man-made fibres; the variability of the natural fibres permitted a degree of tolerance in textile machinery which is no longer desirable if the best results are to be obtained from the more uniform man-made products. At the same time, the textile industry as a whole requires its machinery to be much more flexible in respect to the range of raw materials available, especially as these can now be processed more satisfactorily than was formerly the case. The reconciliation of these two conflicting requirements is probably the main problem now facing the textile machinery industry, and at the International Exhibition of Textile Machinery and Accessories at Belle Vue, Manchester, in October, 1958, a high proportion of machinery was offered as suitable for processing a wide range of natural, man-made, and blended fibres.

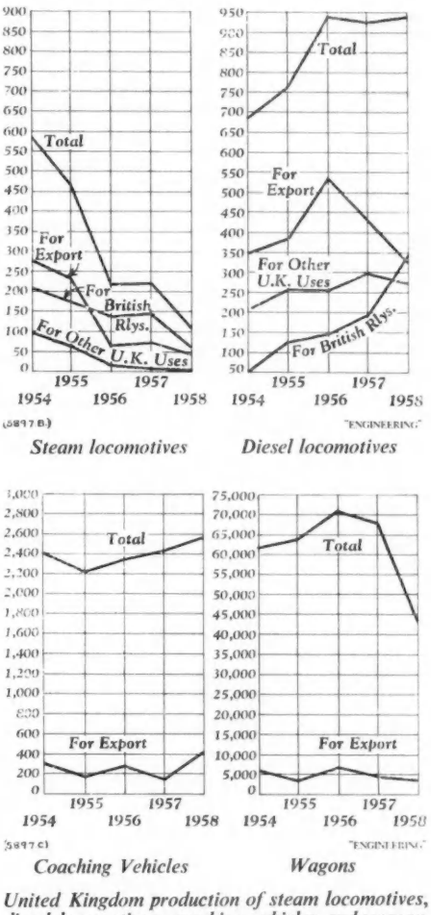
Technological progress in the textile industry was also the subject of an international appraisal at the meeting, in Geneva, of the sixth session of the Textile Committee of the International Labour Organisation. The report issued after the meeting claimed that semi-automatic processes were developed early in respect to textiles and noted that present trends remained largely in the direction of greater productivity through the increased application of automatic methods. One of the factors which has hitherto restricted the application of automatic methods and continuous operation to the processing of textiles is the lack of homogeneity of the raw material, since this characteristic tends to make economic devices for continuous control extremely complex. The report concluded that automation is likely to increase in the ancillary machinery rather than in the main processes of spinning and weaving; and in man-made rather than in natural fibres, due to their greater homogeneity.

Over the world as a whole, another matter which limits the spread of automatic methods is the economic consideration that the majority of textile mills are not large-scale units. This position, however, is not an overriding consideration, because, if automatic methods were found to be feasible and to show substantial advantages, they should, in effect, be a factor encouraging the growth of large-scale enterprises. The report discussed in some detail the application of automatic methods to the various textile processes, but this aspect is outside the scope of the present article. The main relevance of the report to the textile machinery industry in Britain would seem to be that this industry, if it is to preserve its present market and look to expansion in the future, must concentrate on the development of the more complex machinery and on the application of automatic methods where these are applicable, with a view to encouraging the growth of large-scale units in the textile industry throughout the world, since it is only in the supply of such machinery that the British manufacturers can exert their full competitive strength.

In the immediate future, a sharp revival of the recent downward trend of demand seems unlikely, because industrial recovery will probably have to proceed some distance before there is much increase in demands for textile machinery. While India's immediate financial difficulties have been resolved, neither India nor any other developing country can count on having greatly increased funds available for the purchase of textile machinery in the immediate future. Accordingly, much of the available export business may well be subject to the acceptance by the suppliers of long-term credit conditions. If, however, the recovery in the United States continues, and industrial expansion in Britain can be resumed, there may well be some recovery in both home and export demand towards the end of the current year.

What the Future Holds for LOCOMOTIVES AND ROLLING STOCK

The outlook for the locomotive and rolling stock industry changes from bright to grey and back to bright with great rapidity, depending on the current state of mind of British Railways. At the end of 1957, the Minister of Transport threw some cold water on the prospects for diesel locomotives, and he forecast slower progress in their adoption than had been planned. By the second quarter of the year, the railways, faced with the double problem of wage and salary claims and falling receipts, pressed for and obtained Government permission to spend a total of £170 million on modernisation in 1958, and again in 1959; this expenditure being in place of the £145 million in both years which was set up as an upper limit at the time of the investment cuts of the autumn of 1957.



United Kingdom production of steam locomotives, diesel locomotives, coaching vehicles and wagons, 1954 to 1958.

At that point, the manufacturers—certainly manufacturers of locomotives—seemed well set for the next two years. They were previously assured of a rising production of diesel locomotives, at least during 1958. Large further orders were placed in the summer of 1958 (in August, the total main-line diesels on order, or delivered, was quoted as 586), thus ensuring a continued rise in output for 1959 at least. It was an expressed hope early in the summer of last year that, by a combination of a selective raising of charges, economies, and accelerated modernisation (with the emphasis on those aspects likely to bring quick returns), the railways might be able to finance the agreed wage increases—costing some £11 million in a full year—and cover the fall in receipts, amounting to some £15 million a year.

At the time, this aspiration met with some scepticism, though it was freely admitted that both economies and efficiency through modernisation should be pursued as diligently as possible. The extent of the loss in 1958 was hardly foreseen.

Early last November, the 1958 loss was estimated as £85 million. By September, takings for the year were down by £18 million, compared with the corresponding period of 1957, and, since the summer, the decline in coal and steel traffic had become still more serious; the British Transport Commission estimated that this decline alone was costing them over £30 million a year. Freight receipts, in fact, were down by at least 7 per cent and were the main cause of the trouble.

The railways had been given permission to borrow up to £250 million during the period 1956 to 1962, in order to finance deficits. By the end of 1958, the accumulated deficit was estimated as £203 million. The Government has now agreed to underwrite deficits of up to £400 million in the period up to 1962, provided that the railways' economies are pressed even more ruthlessly. Furthermore, the Commission's borrowing powers for capital expenditure were

Continuing

What the Future Holds

raised from £600 million to £1,200 million, to cover modernisation expenditure over the next three or four years.

The comparatively mild recession has shown, if it needed showing, how vulnerable the railways are. With far too great a dependence on the transport of one commodity, coal, and the future of that commodity not too secure, the prospect of a continuing heavy loss on the railways is not impossible. Against this background, an urgent examination of the whole modernisation plan is being undertaken by the Transport Commission, which will report to the Government by the spring of this year, and immediate plans were put in hand last December for intensifying modernisation over a narrower sector—again to bring quicker returns. As this examination was announced, the Minister of Transport said that no departure had been made from the estimated break-even date of 1962 —" at present." With the best will possible, this seems optimistic. Unless something remarkable happens, it looks as if the railways will be on the Government's hands for far longer than 3 years.

This rather gloomy prospect leaves the railways' suppliers in a somewhat similar position to that which the aircraft industry has been facing; with one main customer bedevilled by financial problems and constantly changing its mind on a grand scale. From the manufacturers' point of view, however, there are two important differences for consolation. These are that, in the first place, the railways are an essential public service which, as opposed to military aircraft, cannot be supplied by the Americans, or—in any reasonable time—by anyone else; and, in the second place, that expenditure on modernisation has already been so heavy that there can be no question of going back. Money is better spent on new and profitable equipment than in financing deficits; or, looked at another way, if the taxpayer is going to foot the bill indefinitely he may as well travel in comfort and on time. It is to be hoped that a realistic appraisal of the situation will emerge during the coming spring.

Whatever the outcome of the Transport Commission's investigation, it is extremely unlikely that cuts will be made in the locomotive building programme. The Minister of Transport stated in December last year that, as far as electrification is concerned, the Commission proposed to concentrate, in the immediate future, on the London-to-Manchester and Liverpool line, and that it was hoped to accelerate the completion of this line by several years. The programme for diesel locomotives was to be accelerated, particularly on the route north of Newcastle, to eliminate the use of steam on an area basis as quickly as possible. By 1961, nearly 1,100 main-line diesel locomotives should be in service. There would also be a scrapping of obsolete wagons.

The first stage of the British Railways' plan to promote diesel locomotion consisted largely of the introduction of large numbers of diesel railcars. Some 4,600 of these are due to be operating by the end of 1961. By September of last year, half that number were already in service. The introduction of diesel locomotives has proceeded steadily during the past year. At the beginning of 1958, there were 22 in service; by the beginning of September, the number had risen to 68; and it was expected that about 140 diesel locomotives would be in service by the end of the year. The maximum rate of production envisaged has been about 200 a year, and, since increasing emphasis is likely to be placed on their introduction, this rate of production may, in fact, be exceeded. Following the increased investment authorised early in the summer, extensive further orders were placed for main-line diesel locomotives and the numbers on order, or already delivered, by September, totalled 586. Of these, the greatest number (358) consisted of the type 2, of 1,000 to 1,250 h.p.

As would be expected, the output of steam locomotives has begun to tail off, the estimated total figure in 1958 being 109, compared with 220 in 1957. This decline is spread not only over British Railways, but also over the field of industrial locomotives and those produced for export. The total numbers of diesel and diesel-electric locomotives produced (though this estimate is based only on the first six months of 1958) have not risen to any startling extent. The true picture, however, is disguised by the fact that the increase in their production has taken place in regard to the larger locomotives; for example, the production of diesel and diesel-electric locomotives for main-line railways in the United Kingdom, of 275 h.p. capacity and over, has risen from 12 in the first quarter of 1957, to 87 in the second quarter of 1958. The diagram on the previous page clearly shows the increasing purchases by British Railways of diesel and diesel-electric locomotives.

In export markets, 1958 showed an improvement in the locomotive and rolling-stock field as a whole, total exports returning to the level achieved in 1956. This satisfactory position was due to a large increase in exports of railway carriages. Exports of locomotives of all kinds declined, the heaviest drop being in diesel-electric types.

The largest export markets, by a long way, are now those of the Union of South Africa and the Central African Federation, accounting for over 80 per cent of exports in 1958; and, with the improvement in copper prices, the latter area will be somewhat better placed to finance its imports during 1959. Exports of locomotives to India (estimated at only £140,000 in 1958) are now but a tenth part of the figure achieved in 1956. On the whole, the trend shown in 1957, whereby locomotive exports declined in value but exports of wagons, and more particularly of railway vehicle parts, increased, has continued.

The locomotive and rolling stock manufacturers are thus just holding their own in export markets. So far as the home market is concerned, the independent manufacturers are still receiving a large part of the total orders for British Railways. An analysis made in September last showed that, of the 586 main-line diesel locomotives ordered at that time, only 157 would be built by British Railways workshops.

There is hope, that for some years to come the continued decline in export markets will be offset by the steady demand at home. Some wagon manufacturers, however, are in a less happy position; for example, at the end of last year, one company reported the redundancy of about 300 workers, due to the falling off of orders for rolling stock, particularly wagons.

TABLE II.—*United Kingdom: Exports of Locomotives and Rolling Stock*

	Quantities (tons)			Value (£1,000)		
	1956	1957	1958*	1956	1957	1958*
Complete locomotives:						
Steam	12,714	9,794	7,845	4,091	3,714	3,010
Others	19,669	12,834	9,533	12,963	8,341	6,534
Railcars	1,095	309	343	962	236	239
Railway carriages, complete	7,016	5,352	16,165	4,296	3,253	9,063
Wagons and trucks, complete	23,973	27,088	28,988	3,093	3,798	4,286
Parts of railway vehicles:						
Axles, tyres and wheels	81,087	142,924	111,432	6,197	9,556	9,716
Other n.e.s.:						
For railway carriages	4,102	5,507	7,740	1,906	2,250	2,797
For wagons and trucks	43,714	40,951	19,052	5,050	4,453	2,762
Others	16,670	17,539	17,223	6,670	6,296	6,772
Totals	210,040	262,298	218,321	45,228	41,897	45,179

* Nine months annual rate.

Atomic Review

Reactors Abroad

NUCLEAR reactors planned, under construction or operating overseas, are featured in the following items. We also continue out series on national programmes with four more countries.

US Reactors in 1958

During 1958 the United States completed at home and overseas 37 nuclear reactors (including one small power experiment and 27 small research and training devices), according to a detailed and comprehensive report published by the Atomic Industrial Forum, the national association of the US atomic industry. In the propulsion field the power plants for the nuclear submarines Swordfish and Sargo were completed; as were a dual-reactor land-based prototype of the power plant for the first large United States naval surface vessel; a single-reactor land-based prototype for an advanced submarine reactor; and a ground-test experiment of a reactor for rocket propulsion. Other reactors completed included a small transportable reactor for Army bases and two high-flux test reactors. The US also began building in America and abroad a further 45 reactors, including two power reactors, another Army reactor, 13 submarine reactors, a propulsion plant for a destroyer and its land-based prototype, three large test reactors, and two small power reactor experiments.

American High Temperature Reactor

As reported in Atomic Review on 26 December, 1958, a group of 51 utilities in the United States have formed a joint company, High Temperature Reactor Development Associates, to sponsor construction of an advanced gas-cooled graphite-moderated reactor designed by the General Atomics Division of the General Dynamics Corporation. The arrangement of the reactor, which would be helium cooled and have an eventual electrical capacity of 40 MW, is shown in Fig. 1. The principal designer of the reactor is reported to be Dr. P. Fortescue, who is on extended leave from the Atomic Energy Research Establishment, Harwell, to General Dynamics, and who initiated work on Britain's High Temperature Gas Cooled Reactor (HTGC).

The first core is expected to have metal-clad fuel elements comprising a homogeneous mixture of carbon, fully enriched uranium carbide, and thorium carbide. Coolant entering the core at 582° F (305° C) would emerge at 1,015° F (546° C) giving steam conditions of 850° F (454° C) and 850 lb per sq. in. The electrical output would at that stage be 30 MW. The second core, on which development is in progress, would have entirely ceramic elements contained in long impervious graphite tubes as designed for the HTGC reactor. The net electrical output would then be raised to 40 MW (115 MW thermal). Gas inlet and outlet temperatures would be 662° F (350° C) and 1,382° F (750° C), and gas flow at nominal power would be 440,000 lb per hour. Steam conditions would be 1,000° F (538° C) and 1,450 lb per sq. in with a flow of 367,000 lb per hour. Thermal efficiency works out at 37 per cent with a fuel-element lifetime of 3 years at 80 per cent load factor. The first core might prove to be unnecessary. A 325 MW (electrical) version is expected to be economical in

certain areas of the United States. The arrangement of the core and double pressure vessel can be seen from Fig. 1.

Westinghouse and Pennsylvania Withdraw

The USAEC have announced that the Pennsylvania Power and Light Company and the Westinghouse Electric Corporation have withdrawn their proposal to build a nuclear power plant under the Commission's Power Demonstration Reactor Programme. The plant was to be a 70 to 150 MW aqueous homogeneous reactor but adequate support was not forthcoming. This decision may serve to confirm British policy on the aqueous homogeneous system.

Activity Build-up in a PWR

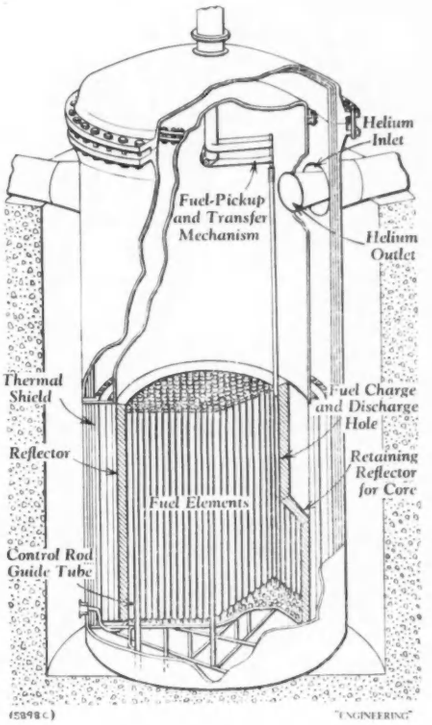
A problem associated with pressurised-water reactor systems is that long-lived radioactive deposits tend to build up on the surfaces of the primary loop. On parts of the loop outside the core these deposits may reach levels high enough to hamper maintenance operations. The problem is intensified if stainless steel is used in regions of high flux. Cobalt 60 is produced by *n-γ* reactions on cobalt 59 and both cobalt 58 and cobalt 60 result from *n-p* reactions on nickel. Accordingly a research programme has been undertaken on the Army Package Power Reactor and a report, " Activity Build-Up in the Primary System of a Pressurised-Water Reactor with Stainless Steel Fuel Elements and Core Support Structure," has been prepared by Captain H. L. Arnold for the USAEC's series of *Nuclear Technology Briefs*.

Spert-III Achieves Criticality

Special Power Excursion Reactor Test No. 3 (SPERT-III), a versatile research facility developed for studying nuclear reactor safety, achieved criticality on 20 December, 1958, at the USAEC's National Reactor Testing Station. SPERT-III is one of a series of reactors designed and developed by Phillips Petroleum Company, which operates the facility for the USAEC as part of the Commission's programme to find basic explanations for reactor behaviour under run-away conditions.

A series of nuclear physics measurements leading to a special programme of reactor hazards studies will be started immediately in SPERT-III. Although SPERT-III is classified as a high-pressure high-temperature light-water moderated and cooled reactor, its versatility will enable the performance of transient tests under various initial conditions of pressure, temperature and coolant flow. Pressures ranging from atmospheric to 2,500 lb per sq. in, and water temperatures from 68° F to 668° F are attainable in the complex facility. Also, coolant flow rates range from zero to 20,000 gal per min., with heat removal capacities up to 60 MW for a duration of 30 minutes. SPERT-III can be used, therefore, to investigate conditions applicable to many reactor fields, including both pressurised and boiling water systems. The facility comprises a reactor vessel pressurising tank and two primary coolant loops, including pumps, heat exchangers, and other necessary auxiliary equipment. The reactor and coolant system are designed to be operated from a control centre one-half mile away. SPERT-III is fuelled with highly enriched uranium. Positions are provided in the reactor for 68 fuel assemblies, including the fuel sections of the eight control rods. The reactor vessel itself is capable of withstanding shock pressures up to 3,500 lb per sq. in.

Fig. 1 Arrangement of helium-cooled reactor being designed for High Temperature Reactor Development Associates.



BWR with Superheater for Puerto Rico

The USAEC has approved, as a basis for contract negotiation, the design-study phase of a proposal from the Puerto Rico Water Resources Authority for a boiling-water nuclear power plant incorporating a nuclear-fired superheater to increase steam temperatures. The Puerto Rico Water Resources Authority plans to engage the General Nuclear Engineering Corporation of Dunedin, Florida, to perform the study. The Commission's approval of the design study does not represent a commitment to build a reactor in Puerto Rico. Although superheated steam has the potential of reducing capital and fuel costs, there is insufficient engineering data at the present time to determine if the additional design complexities introduced by nuclear superheat would prevent realisation of expected gains. Anticipated reductions in unit capital costs would result from increased plant efficiency due to higher steam temperature and a simplified turbine and associated equipment made possible by the use of dry steam at the turbine throttle. Expected reductions in fuel costs would result from increased heat efficiency and the resulting reduction in fuel burnup.

Dual-Core Reactor

A dual-core reactor is to be built on the campus of Cornell University at Ithaca, New York, for use in student instruction and research. The facility, to be known as the Cornell Dual Core Reactor, will consist of a pool-type light-water moderated reactor designed to operate at a power level (thermal) of 10 kW for research purposes and at thermal power levels of less than 10 watts for instructional purposes. The 10 kW core will be immersed in a pool of demineralised water, while the low-power core will rest in an aluminium tank. A single system of instruments will control operation of the dual-core reactor.

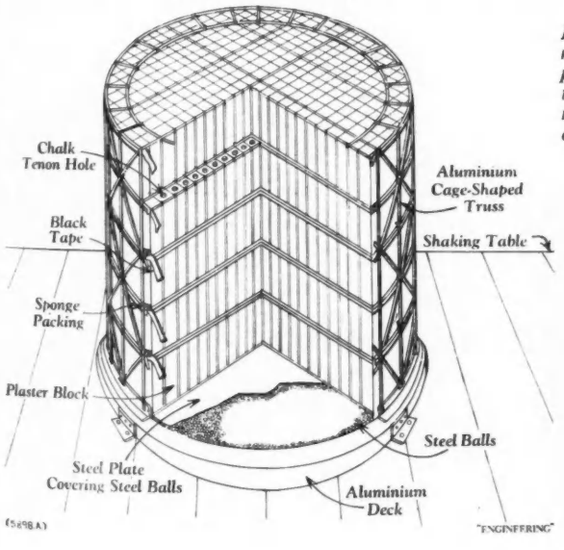


Fig. 2 Arrangement of aseismic reinforcing truss and piling of plaster blocks in a model built to test the effectiveness of a reinforcing cage for the cores of Calder type reactors.

Aseismic Reinforcement for Calder Type Core

Since aseismic considerations were largely neglected in the design of the Calder Hall reactor, a suitable method of reinforcement is required if a reactor of this type is to resist earthquakes when it is built in Japan. This reinforcement should call for no essential change in the construction inside the pressure vessel. In a paper, " Experimental Study of a Method of Aseismic Reinforcement Recommended for the Calder Hall Type Reactor," by Tachu Naito and others of Waseda University, Tokyo, the authors propose a cage-shaped truss-work, such as that illustrated in Fig. 2, surrounding the graphite core.

A model experiment was made for the purpose of checking the basic idea and securing qualitative rather than quantitative information about the general behaviour of such a reinforced structure. The model blocks which correspond to the actual graphite blocks are casts of plaster and the core comprises some 2,000. Two kinds of truss have been constructed, one of steel and the other of aluminium. The former truss is used for the determination of the stress-distribution, while the latter is for investigating the deformation. The model reactor is tested on the shaking table which is capable of giving a horizontal acceleration of 0·6*g* as the maximum.

A comparison has been made between the stresses which are produced in various members constituting the truss and the deformations of the cage when the forces are applied to the model statically and dynamically. In addition, the effectiveness of the bracing members lying on the tension and the compression sides has been established experimentally. The results showed that the stresses which were produced dynamically in the oblique members were always smaller than those produced statically. Notwithstanding the shaking test which lasted several days, the plaster blocks kept their initial aspect and the damage was hardly perceptible. As to the effectiveness of the bracing, it was made clear that the members on the compression side could assume one half of the load imposed on the members on the tension side.

Continuing Atomic Review

Zerlina Ready in 1959

Zerlina, India's second reactor, is due to go into operation by the middle of next year. Six months later the Canada-India Reactor, based on Canada's research reactor NRX, will be ready India's first reactor, Aspara, of swimming-pool type, attained criticality in August, 1956. Zerlina will be used for fuel studies.

Swedish Power Reactor

It is reported that the Swedish nuclear power group Krangede is to begin construction of 100 to 200 MW nuclear power station in 1961. The project, which is expected to cost £55 million, is scheduled for completion in 1965.

Power Reactor for Spain

A 250 MW nuclear power stations is to be built on the Ebro by Nuclenor SA and is expected to start operating in 1965.

World Programme

Mexico, the Netherlands, New Zealand and Norway provide the subjects of the following notes, which continue our series on national atomic energy programmes.

Mexico

The Comision Federal de Electricidad has investigated the economics of installing a 35 MW nuclear power station at Chihuahua, while the Instituto de Fisica is interested in acquiring a research reactor. No definite plans have been made however.

Deposits of uranium have been discovered at more than a dozen points in northern Mexico, with an output of 50 tons of ore per month, yielding 2·7 per cent of uranium, from the most important site.

Netherlands

The total energy consumption in the Netherlands increased by 100 per cent between 1921 and 1939, and has continued to rise at a growing rate. The exploitation of domestic resources is already very advanced, and the price of conventional power is likely to rise with the increasing costs of transport, and fuel treatment. A programme has therefore been undertaken by the Netherlands Government for the construction of a number of nuclear power stations, the first in 1962, which are planned to contribute 51 per cent of the national electricity supply by 1975.

Research

The Reactor Centrum Nederland was set up in 1955, and is controlled by the Netherlands Government; the Company for the Testing of Electrotechnical Materials (KEMA), representing the electricity supply companies; the Foundation for Fundamental Research on Matter (FOM), which has also been the Netherlands partner in the Netherlands-Norwegian Joint Establishment for Nuclear Energy Research, at Kjeller, in Norway, since 1951; and a large number of industrial undertakings.

Constructional work was begun in 1957 on the reactor centre at Petten. The reactor around which the research programme will be built is a high-flux reactor purchased from the USA, of $1{\cdot}5 \times 10^{14}$ neutrons per sq. cm per sec thermal flux and 20 MW thermal output. The reactor is expected to be completed in the spring of this year, when experimental work and testing can be started.

Parallel to the developments at Petten, other work is being done at Arnhem, under the auspices of KEMA, but financed by RCN. Two small reactors are being built, a zero-energy reactor to be erected in the physics laboratory of KEMA, and a 250 kW reactor to be housed in a new building. This work is planned to lead towards the construction of a suspension reactor fuelled with slightly enriched uranium, a first step in the actual development of a Netherlands-built reactor.

As the participation of industry would suggest, the activities of RCN are directed towards the utilisation of nuclear power by the training of engineers and scientists and the development of Netherlands reactors.

Propulsion

The Foundation for the Nuclear Propulsion of Merchant Vessels (Stichting Kernvoortstuwing Koopvaardijschepen) is supported by shipping and shipbuilding interests, and works in close liaison with the RCN. It has been reported that the Dutch Government is considering the construction of a nuclear submarine.

Agreements

The Netherlands Government have concluded agreements with the United States for co-operation in the peaceful application of atomic energy, and with the United Kingdom, and is associated with Euratom and OEEC nuclear activities. There is also the co-operation between the Netherlands and Norway referred to above and discussed in greater detail under Norway below.

New Zealand

A small country with a relatively small population, New Zealand has undeveloped hydro-electric potentialities sufficient for expansion over a number of years, although supply is not at present keeping up with demand. There are no immediate plans for atomic power installations.

Resources

Uranium deposits have been discovered which could be substantial, but a good deal of sampling needs to be done before the economic possibilities are definitely known. Some thorium is present in the extensive titano-magnetite iron sands, and it is estimated that as much as 1,300 tons of lithium per year might be extracted from the geothermal steam at the Wairakei power installations. The plan to use geothermal steam for heavy-water production was discontinued.

Research

A limited amount of nuclear science research work has been pursued at the various university colleges of the University of New Zealand, utilising a 600 kV Cockcroft-Walton accelerator and a small auxiliary 120 kV proton accelerator, a 12 in cloud chamber with associated electronic equipment, counters, neutron piles, etc., and a Van de Graaf accelerator, among other equipment. Work on isotope techniques has been carried out by a division of the New Zealand DSIR set up in 1955.

The Institute of Nuclear Science was set up in 1958 as a branch of DSIR. They intend to purchase a 3 MeV particle accelerator, and later a small research reactor, partly financed by a United States grant.

Norway

The construction of the reactor installation JEEP at the Netherlands-Norwegian Joint Establishment for Nuclear Energy Research (JENER) was begun at Kjeller in Norway in 1948. JEEP, a natural-uranium heavy-water cooled and moderated reactor, became critical in July, 1951, and is used for the production of radioactive isotopes for both home and foreign needs, largely within Scandinavia (Norway was the first country after the United Kingdom and United States to export radioactive isotopes); for neutron beam experiments; for measurement of reactivity exchanges; and for training, notably in connection with the recently founded Netherlands-Norwegian Reactor School.

The construction of the Halden Boiling Heavy Water Reactor, also at Kjeller, was started in 1956, and a three-year agreement for co-operative support and use of the reactor was signed in June, 1958, by Norway, Sweden, Denmark, the United Kingdom, Switzerland, Austria, and Euratom. United States technical aid will probably be made available in addition. The reactor will, it is expected, have a capacity of 20 MW, and because of its small size may well be considered as a prototype for the construction of nuclear steam plants in the smaller range. It may also be a step in the evolution of a nuclear plant suitable for ship propulsion. It is intended that the plant shall in fact supply steam to the paper and pulp manufacturers, Saugbrugsforeningen, when the major research objectives have been reached.

Plans

Oslo Lysverk, the municipal electricity undertaking, is reported to be interested in the possibility of installing a "Stockholm" rector, primarily for heating, to replace an old conventional station. Noratom are to make a study of a 20 to 50 MW plant.

Consortium

Noratom A/S was set up in 1957, largely concerned with the development of nuclear propulsion, and of nuclear reactors for export. The membership of the group comprises industries of all kinds, government departments, research institutions and professional organisations.

Notes and News

Dock for Dreadnought

The keel of Admiralty Floating Dock 59 was laid at HM Dockyard, Portsmouth, on 1 January. The dock will be capable of accepting submarines of the latest types including the nuclear submarine Dreadnought. The dimensions of the dock have been so arranged that destroyers and frigates can also be accommodated. The hull design of the Dreadnought is based on the Albacore form developed by the United States Navy and will be similar in some respects to that of the Skipjack. On completion the new dock will be towed to the Vickers-Armstrongs yards at Barrow-in-Furness where the submarine is to be built.

Fuel Element by Co-extrusion

A fuel element produced using a co-extrusion process was shown at the recent 23rd National Exposition of Power and Mechanical Engineering in New York. The principal component is a uranium alloy tube, the two surfaces of which are clad with zirconium alloy; the ends are closed by two integral zirconium end pieces. Excellent bonding and dimensional uniformity are claimed for this process.

Atoms for Peace in Photographs

A booklet containing "Highlights from the *Atoms for Peace Digest* 1956-1958" has been published by the United States Information Service in London, US Embassy, Grosvenor Square, London, W.1. It provides a record in photographs of American atomic energy work during those years.

Distribution of Isotope Interest

Among the 1,000 or so students so far enrolled at the Isotope School, Harwell, many branches of science are represented. Chemistry heads the list with 37 per cent, followed by medicine with 18 per cent and physics with 14 per cent. 40 per cent have come from industry, 30 per cent from Government and other research laboratories including those of the UKAEA. Universities supply 22 per cent and hospitals the remaining 8 per cent.

Course on Control and Instrumentation

A second course on the control and instrumentation of reactors will be held at the Harwell Reactor School from 7 to 17 July, 1959, inclusive, and will be open to British and overseas students. The course is primarily intended for those who have a direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects. The topics to be treated will include: revision of elementary reactor kinetics, control and instrumentation; automatic control of reactors and nuclear power plants; application of computers; reactor transfer functions and function analysers; neutron flux scanning; radiation detectors and their siting in reactors; reactor safety circuits; conventional instrumentation; use of transistors in reactor instrumentation; burst slug detection; spatial instabilities in reactors; and data reduction problems on large reactors. The fee for the course will be 50 guineas, exclusive of accommodation, and application forms, available from the Reactor School, must be returned by 7 May, 1959, to: the principal of the Reactor School, Atomic Energy Research Establishment, Harwell, Didcot, Berkshire.

Course for Senior Technical Executives

From time to time courses for senior technical executives in industry are held at the Harwell Reactor School. The next of these courses on which places are available will be held from 15 to 25 June, 1959. The fee for the course is 50 guineas exclusive of accommodation and those who are interested should apply for application forms and details from the principal of the Reactor School.

Postgraduate Courses

The basic principles of nuclear engineering and arc and glow discharges (including plasma theory) provide the subjects of two post-graduate courses to be held by the Department of Extra-Mural Studies, University of Liverpool, from 12 to 18 April and 12 to 17 April, 1959, respectively. Inquiries should be addressed to the director of the department at 9 Abercromby Square, Liverpool 7.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

NOTTINGHAM
"Miniature Circuit-Breakers in Modern Installations," by J. A. Robbins. Nottingham Branch. Mechanics' Institute, Trinity Square, Nottingham. Wed., 21 Jan., 7.30 p.m.

British Computer Society

LONDON
"The Study of the Application of a Computer to Production Control," by D. C. Hemy. Northampton College of Advanced Technology, St. John Street, E.C.1. Mon., 19 Jan., 6.15 p.m.*

British Institution of Radio Engineers

LONDON
Inaugural meeting of the Medical Electronics Group, with an address by Professor A. V. Hill. London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Fri., 23 Jan., 6.30 p.m.*
WOLVERHAMPTON
"Learning Machines," by P. Huggins. West Midlands Section. Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton. Wed., 21 Jan., 7.15 p.m.

Building Centre

LONDON
Films on "Prestressed Arch Construction," exhibited by the Demolition and Construction Co., Ltd. Wed., 21 Jan., 12.45 p.m.

Chemical Society

BRISTOL
"Safety in the Use and Disposal of Radioactive Materials," by Dr. B. A. J. Lister. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., 22 Jan., 6.30 p.m.
NEWCASTLE UPON TYNE
Tilden Lecture on "The Triplet State in Chemistry," by Professor G. Porter. Newcastle upon Tyne Branch. Chemistry Department, King's College, Newcastle upon Tyne. Tues., 20 Jan., 5.30 p.m.

Combustion Engineering Association

BIRMINGHAM
Discussion on "Should the Boiler Operator be a Trained Man?" opened by C. A. J. Plummer, G. W. Hipkiss and N. Marshall. Midland Region. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Wed., 21 Jan., 10 a.m.

Engineers' Guild

BARKINGSIDE
Evening Meeting. South West Essex Centre. Doctor Johnson Hotel, Barkingside. Mon., 19 Jan., 8 p.m.

Illuminating Engineering Society

BRISTOL
"Open Space Lighting," by M. W. Pierce and H. F. Stephenson. Bath and Bristol Centre. Showrooms of Gardiner, Sons and Co., Ltd., Broad Plain, Bristol. Mon., 19 Jan., 7 p.m.
LIVERPOOL
"New Light Sources," by F. Jackson. Liverpool Centre. Development Centre of the Merseyside and North Wales Electricity Board, Liverpool. Tues., 20 Jan., 6 p.m.

Incorporated Plant Engineers

LONDON
"Engineering Problems Encountered by the Trans-Antarctic Expedition, with Particular Reference to Maintenance," by D. L. Pratt. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, S.W.1. Mon., 19 Jan., 7 p.m. (Tickets required.)
LIVERPOOL
"Earthing Appliances," by J. A. Robbins. Merseyside and North Wales Branch. Exchange Hotel, Liverpool. Thurs., 22 Jan., 7.15 p.m.
ROCHESTER
"The Management of Men," by the Bishop of Rochester. Kent Branch, King's Head Hotel, High Street, Rochester. Wed., 21 Jan., 7 p.m.

Incorporated Sales Managers' Association

DARLINGTON
Films: "How to Sell Quality" and "Overcoming Objections." Tees-Side and S.W. Durham Branch. White Horse Hotel, Darlington. Mon., 19 Jan., 7 p.m.

Institute of Marine Engineers

LONDON
Film Evening. Mon., 19 Jan., 6.15 p.m.*
BATH
"Welding in Marine Engineering," by J. A. Dorrat. West of England Section. Smith's Assembly Rooms, Bath. Mon., 19 Jan., 7.30 p.m.
NEWPORT
"Duties in the Day of a Seagoing Officer," by T. C. Bishop. South Wales Section. Newport and Monmouthshire College of Technology, Allt-yr-yn Avenue, Newport. Thurs., 22 Jan., 2.30 p.m.

Institute of Metals

BIRMINGHAM
"Mechanism of Solidification of Cast Iron," by H. Morrogh. Birmingham Local Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Thurs., 22 Jan., 6.30 p.m.
SHEFFIELD
Short papers giving accounts of research in progress in local laboratories. Sheffield Local Section. Engineering Department, The University, St. George's Square, Sheffield 1. Thurs., 22 Jan., 7.30 p.m.

Institute of Road Transport Engineers

LONDON
"Continental Trends in the Design and Manufacture of Heavy Commercial Vehicles," by A. R. J. Van Der Goes. Royal Society of Arts, John Adam Street, W.C.2. Thurs., 22 Jan., 6.30 p.m.
LIVERPOOL
Discussion on "Causes and Prevention of Road Accidents." West Regional Centre. Liverpool Architectural Society, Bluecoat Chambers, School Lane, Liverpool 1. Tues., 20 Jan., 7.30 p.m.

Institution of Chemical Engineers

CHESTER
"Separation of Isotopes by Molecular Distillation," by P. T. Nettley. North Western Branch. Blossoms Hotel, Chester. Tues., 20 Jan., 7 p.m.

Institution of Civil Engineers

LONDON
"The Engineer's and Architect's Roles in a Specific Case of Planning or Construction," by Ove Arup and E. D. Jefferiss Mathews. Joint meeting with the Royal Institute of British Architects. Tues., 20 Jan., 5.30 p.m.*
Vernon Harcourt Lecture on "Hydraulic Models," by F. H. Allen. Wed., 21 Jan., 6.30 p.m.*
BIRMINGHAM
"Some Aspects of Traffic Engineering," by J. Loveday. Civic Centre, Birmingham. Wed., 21 Jan., 6 p.m.*
LIVERPOOL
"Aerial Surveys in Liverpool Bay," by D. M. Clapp and R. B. Whittington. North Western Association. 9 The Temple, 24 Dale Street, Liverpool. Wed., 21 Jan., 6.30 p.m.

Institution of Electrical Engineers

LONDON
"High-Current-Density Thermionic Emitters," by A. H. W. Beck. Radio and Telecommunication Section. Mon., 19 Jan., 5.30 p.m.*
Discussion on "Direct-Current Amplifiers," opened by K. Kandiah. Measurement and Control Section. Tues., 20 Jan., 5.30 p.m.*
"Dielectric Materials—Trends and Prospects," by C. G. Garton. Radio and Telecommunication Section. Wed., 21 Jan., 5.30 p.m.*
"Subscriber Trunk Dialling," by D. A. Barron. Thurs., 22 Jan., 5.30 p.m.*
BOURNEMOUTH
"Domestic High-Fidelity Reproduction," by J. Moir. Southern Centre. Grand Hotel, Bournemouth. Wed., 21 Jan., 6.30 p.m.*
EDINBURGH
"Results of Full-Scale Stability Tests on the British 132 kV Grid System," by F. Busemann and W. Casson. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Tues., 20 Jan., 7 p.m.
GLASGOW
"Results of Full-Scale Stability Tests on the British 132 kV Grid System," by F. Busemann and W. Casson. South West Scotland Sub-centre. 39 Elmbank Crescent, Glasgow, C.2. Wed., 21 Jan., 7 p.m.

Institution of Heating and Ventilating Engineers

LEEDS
Discussion on "Heated Suspended Ceilings." Yorkshire Branch. Powolyns Restaurant, Leeds. Wed., 21 Jan., 7.30 p.m.
LIVERPOOL
"Experiences in Firing Shell Boilers," by R. F. W. Guy. Liverpool Branch. College of Building, Clarence Street, Liverpool. Wed., 21 Jan., 6.30 p.m.

Institution of Highway Engineers

EDINBURGH
"Highway Administration," by S. Leach. Scotland Branch. North British Hotel, Edinburgh. Mon., 19 Jan., 7 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "The Effect of Motorways on Vehicle Design and Durability." Automobile Division. Tues., 20 Jan., 6 p.m.*
Discussion on "Trouble with Vibration." Applied Mechanics Group. Wed., 21 Jan., 6 p.m.*
Thomas Lowe Gray Lecture on "Marine Refrigeration," by H. R. Howells. Fri., 23 Jan., 6 p.m.*
"Prediction of Vehicle Performance," by T. J. Brown. London Graduates' Section. Thurs., 22 Jan., 6.30 p.m.*
FARNBOROUGH
"Impact of Engineering on Society," by Sir Maurice Bowra. Southern Branch. Farnborough Technical College, Boundary Road, Farnborough. Wed., 21 Jan., 7.30 p.m.
SWANSEA
Annual General Meeting. Repetition of the Presidential Address on "The Mechanical Engineering of Aircraft Mechanisms," by Air Marshal Sir H. Owen Jones. South Wales Branch. Showrooms of the South Wales Electricity Board, The Kingsway, Swansea. Tues., 20 Jan., 6 p.m.

Institution of Production Engineers

LONDON
Various short papers on "Aspects of Automatic Control." London Graduate Section. Wed., 21 Jan., 7.15 p.m.
BIRMINGHAM
"Encouraging Innovation in Production Engineering," by the Earl of Halsbury. Birmingham Section. College of Technology, Birmingham. Wed., 21 Jan., 7 p.m.
COVENTRY
"The Approach to the Use of Unit Heads," by J. Hebblethwaite. Coventry Branch. Craven Arms, High Street, Coventry. Mon., 19 Jan., 7.15 p.m.

Institution of the Rubber Industry

SOUTHAMPTON
"Impact of Atomic Energy on Rubber and Plastics," by Dr. D. Roberts. Southern Section. Polygon Hotel, Southampton. Wed., 21 Jan., 7.30 p.m.

Institution of Structural Engineers

LONDON
Maitland Lecture on "Modern Large Span Suspension Bridges," by O. A. Kerensky. Thurs., 22 Jan., 6 p.m.*
GLASGOW
"Field Investigation of Some Engineering Structures," by A. R. Dykes. 39 Elmbank Crescent, Glasgow, C.2. Tues., 20 Jan., 7 p.m.

Junior Institution of Engineers

LONDON
"Cutting and Metal-Working Oils," by W. R. Steet, F. Rogerson and L. A. Cooper. Fri., 23 Jan., 7 p.m.*

Manchester Metallurgical Society

MANCHESTER
"Investigation of Metallurgical Failures in Aircraft," by D. A. Ryder. Central Library, Manchester. Wed., 21 Jan., 6.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"Sea Trials on a Cargo-Passenger Liner with Block Coefficient 0·672 and on a Large Tanker with Block Coefficient 0·77," by Professor G. Aertssen. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 23 Jan., 6.15 p.m.*

Reinforced Concrete Association

BIRMINGHAM
"Some Modern Examples of Reinforced and Prestressed Concrete Works," by A. P. Mason. James Watt Memorial Institute, Birmingham. Fri., 23 Jan., 6.30 p.m.*

Royal Meteorological Society

LONDON
Various short papers. Wed., 21 Jan., 5 p.m.*

Royal Society of Arts

LONDON
"Technical Education: A Prognosis," by Lord Nathan. Wed., 21 Jan., 2.30 p.m.

Royal Society of Health

LONDON
"Health of Workers in Non-Industrial Premises," by Miss Alice Bacon and W. H. Wattleworth. Wed., 21 Jan., 2.30 p.m.

Royal Statistical Society

LONDON
"Production and Productivity Movements in the UK since 1900," by K. S. Lomax. London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Wed., 21 Jan., 5.15 p.m.*

Scientific Film Association

LONDON
"Films in the Service of Science," by Sir George Allen. Shell-Mex House, Strand, W.C.2. Wed., 21 Jan., 6.30 p.m

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting and Presidential Address. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 20 Jan., 7 p.m.

Sheffield Society of Engineers and Metallurgists

SHEFFIELD
Annual General Meeting and Presidential Address. The University, St. George's Square, Sheffield. Mon., 19 Jan., 7.30 p.m.

Society of Chemical Industry

LONDON
Conversazione. Corrosion Group. Battersea College of Technology, S.W.11. Thurs., 22 Jan., 6.30 p.m.

Society of Instrument Technology

CARDIFF
"Data Logging," by C. H. Copley. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 21 Jan., 6.45 p.m.

Television Society

LONDON
Fleming Memorial Lecture on "Modern Optics in Relation to Television," by G. H. Cook. Royal Institution, Albemarle Street, W.1. Thurs., 22 Jan., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, W.C.1. (LANgham 5927.)
British Computer Society, Finsbury Court, Finsbury Pavement, London, E.C.2. (MONarch 6252.)
British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1. (MUSeum 1901.)
Building Centre, 25 Store Street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London. W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, S.W.1. (WHItehall 5536.)
Engineers' Guild, 78 Buckingham Gate, London, S.W.1. (ABBey 7315.)
Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 2 Grosvenor Gardens, London, S.W.1. (SLOane 0469.)
Incorporated Sales Managers' Association, 51 Palace Street, London, S.W.1. (VICtoria 1461.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave Square, London S.W.1. (BELgravia 3291.)
Institute of Road Transport Engineers, 69 Victoria Street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George Street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria Street, London, S.W.1. (ABBey 3891.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1. (VICtoria 0786.)
Manchester Metallurgical Society, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Society of Health, 90 Buckingham Palace Road, London S.W.1. (SLOane 5134.)
Royal Statistical Society, 21 Bentinck Street, London, W.1. (WELbeck 7638.)
Scientific Film Association, 3 Belgrave Square, London, S.W.1. (BELgravia 6188.)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865.)
Sheffield Society of Engineers and Metallurgists, University of Sheffield, St. George's Square, Sheffield 1. (Sheffield 24071.)
Society of Chemical Industry, 14 Belgrave Square, London, S.W.1. (BELgravia 3681.)
Society of Instrument Technology, 20 Queen Anne Street, London, W.1. (LANgham 4251.)
Television Society, 166 Shaftesbury Avenue, London, W.C.2. (TEMple Bar 3330.)

Research and Development

MINIATURE OIL VELOCITY INDICATOR

By A. J. S. BAKER, A.M.I.Mech.E., A.F.Inst.Pet., Regent Oil Co. Ltd., R. TOURRET, B.Sc.(Eng.), A.M.I.Mech.E., F.Inst.Pet., Esso Research Ltd., and J. T. JONES, A.F.Inst.Pet., Admiralty Oil Laboratory

The problem arose, in field trials on the pumpability of furnace fuel oil, of determining the velocity distribution of the oil within the pipeline. To this end an instrument was designed and manufactured at the Admiralty Oil Laboratory. The success of the first instrument (subsequently termed the Mark 1) led to a desire to develop it further, so that accurate absolute velocity determinations could be made in addition to relative measurements. In addition it was considered desirable to alter the design from that of a "one-off" prototype to a batch-production basis and at the same time to encourage a suitable firm to accept the job of manufacturing the indicator. In this way, should a demand arise for these instruments it could be met without recourse to A.O.L.'s limited facilities. The way would also be open for other organisations to obtain replicas if desired.

In this article the design of the instruments and the process of the development work is recorded and details of the calibrations obtained with the latest instrument presented.

Furnace fuel oil may exhibit non-Newtonian behaviour and it was the purpose of the pumping trials to investigate such behaviour. In this connection, it is desirable to know the flow pattern within a pipe. The difficulty was to ascertain what was happening inside the pipeline when pumping took place. One method which would give an indication of the flow pattern of the oil would be to take velocity measurements at a series of stations across the section of the pipe.

As far as was known, there was no suitable proprietary equipment available, chiefly because the fluid was very thick and its velocity too low for accurate measurement. Further, the velocity-sensitive element which necessarily had to be placed in the oil in order to obtain readings at different points, needed to be so small that it would not disturb the flow pattern unduly, or else the whole purpose of the measurement would have been lost.

It was required to insert the velocity indicator into existing pipelines at various points while pumping was in progress. This necessitated the fitting of a suitable cock at each of the points required. In view of the pipe wall thickness being only about $\frac{1}{8}$ in, and the impossibility of welding on pads or bosses due to the fire hazard, it was considered that the largest hole that could safely be drilled and tapped was $\frac{3}{4}$ in BSP. The type of cock which could be used was limited to one with a cylindrical aperture when open. It was found that only one such type of cock existed in regular supply, and in the $\frac{3}{4}$ in BSP size this gave a through hole of slightly over $\frac{5}{8}$ in diameter. This practical limitation coincided with the theoretical need to keep the velocity-sensitive element very small and accordingly all sensing elements were made to pass through a $\frac{5}{8}$ in diameter hole. Other requirements were that no air should enter the pipe while the velocity-sensitive element was either inserted or removed from the pipe. Also, the equipment was to be

Fig. 1 Arrangement of the prototype (Mark 1) oil velocity indicator, which used a magnetic method for determining the number of revolutions of a free-running propeller.

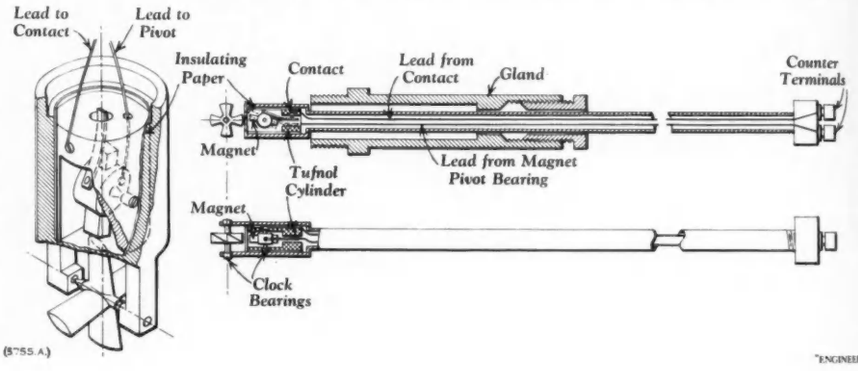
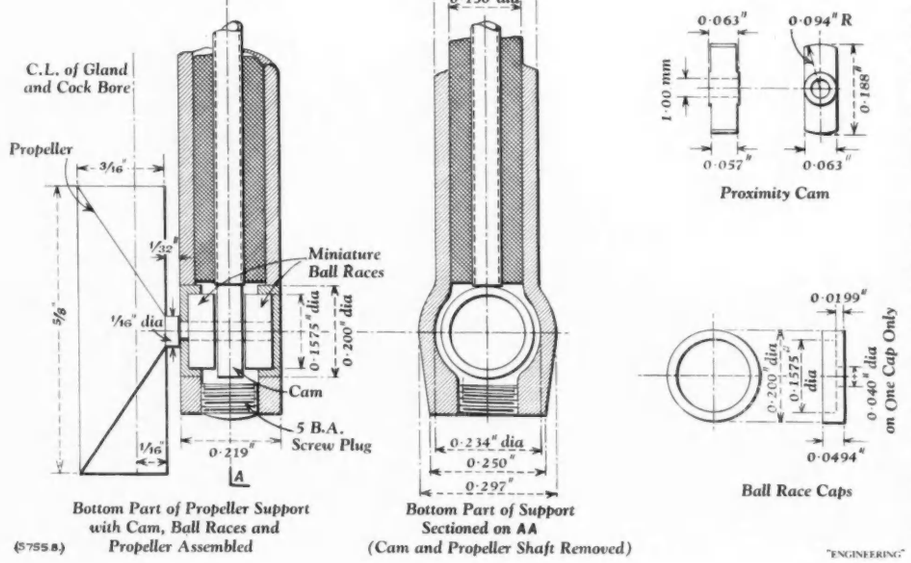


Fig. 2 Sectioned views of the head of the Mark 3 velocity indicator. A capacitance method is used in the later instruments.



reasonably robust and readily portable for use in the field.

FREE-RUNNING PROPELLER

A propeller was selected as the sensing element, since this gave the fewest moving parts immersed in the oil. It was allowed to run free, without any mechanical drive, so that the only frictional resistance to its turning was that of the pivots on which the propeller shaft was poised. The maximum size of the propeller was limited to $\frac{5}{8}$ in diameter if the propeller was arranged to pass the centre-line of the cock, or less if it was arranged offset.

Having decided upon a free-running propeller, the problem then presented itself of counting the number of revolutions made by the propeller. Since furnace fuel oil is not transparent, methods depending on direct light were not open to consideration. One solution to the problem was found for the Mark 1 indicator by making one blade of the propeller of magnetic material and the others of non-magnetic. Just above the propeller, but sealed off from the oil, was pivoted a small magnet which tilted slightly each time the magnetic blade of the propeller passed by, making an electrical contact.

The general arrangement of the velocity indicator is shown in Fig. 1. The outer case of the head was made of non-magnetic material and contained a small bar magnet mounted in clock bearings in a Tufnol plug. The magnet was offset so that when the instrument was in

its vertical position the magnet would hang at about 15° from the vertical. Below the magnet a four-bladed propeller was suspended in a second pair of clock-bearings fixed to two arms integral with the outer case. The propeller was made with three blades of brass and one of steel, and was mounted to give the minimum clearance between the magnet and the blades of the propeller, when separated by the bottom of the outer case. When the steel blade passed the magnet, once each revolution of the propeller, the magnet was displaced, thus closing a miniature pair of contacts. These contacts were connected in circuit to the grid of an electronic amplifier, which operated a Post Office counter. The leads from the contacts to the amplifier were contained in a tube fixed to the outer case and passing through a packed gland, the body of which could be screwed into the ¾ in spherical-plug cock. The tube and outer case of the head were then sealed.

While the Mark 1 indicator was successful for the limited use originally envisaged of determining relative velocities, it was considered that it required improvement if absolute velocities were to be determined accurately. Further, it would be advantageous if both the upper speed limit could be raised and the lower speed limit decreased. It was also considered that the pivot arms tended to obstruct the free flow of oil to and round the propeller and that highly viscous oil caused high pivot friction. In addition the velocity-sensitive element would not operate when mounted at more than a few degrees away from the vertical. The instrument was sensitive to vibration and would occasionally record spurious revolutions.

It was subsequently learned that a propeller had recently been used* as a velocity indicator for measurements in water, but in this case, as the fluid in which the device was to operate was a conducting fluid, the problem of counting the revolutions was handled in a different manner. In this unit the passage of each blade of the non-conducting propeller between two gold probes produced a change in capacitance. These changes were used to create a series of electrical pulses which were counted and timed.

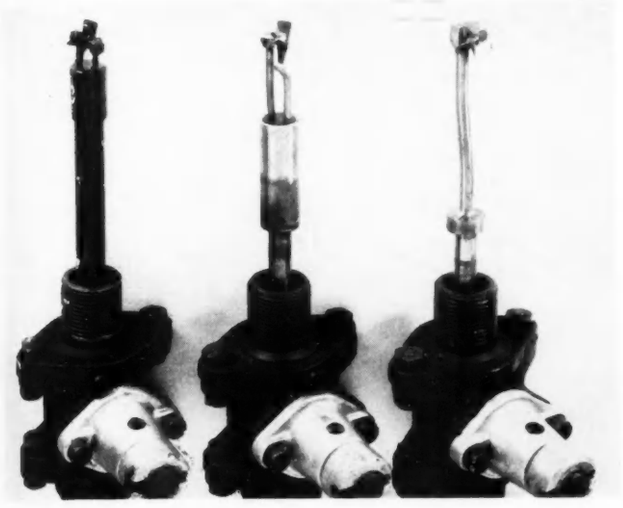


Fig. 3 The reduced obstruction to the flow pattern offered by the Mark 3 head is apparent in this view of Marks 1, 2 and 3 heads.

CAPACITANCE PRINCIPLE

In an attempt to reduce the limitations of the Mark 1 indicator, it was redesigned. While the free running propeller principle was adhered to, the method of counting the revolutions was changed to that of using the change in capacitance produced as the blades of conducting material passed the probe of a proximity meter.

As the four-bladed propeller could now be made from a single piece of mild steel, it was possible to generate it as a helix of approximately 2 in pitch, and to machine it with an integral shaft. The propeller was supported on two knife-edged bearings, their housing being drilled so that the bearings could be pressure lubricated. A capacitance probe was arranged with a small clearance between it and the tip of the blades in their nearest position as the propeller revolved. The probe and bearing housings were fitted in the outer case of the head of the indicator by means of an Araldite plug. The head was fixed to a ⅜ in o.d. tube as in the Mark 1 instrument, and this carried a p.v.c.-covered oil-supply pipe and a co-axial cable; the central electrode of the co-axial cable was the conductor and was soldered directly to the probe. The opposite end of the tube was enlarged to carry the female part of a double co-axial plug. The gland and the body were identical to those of the Mark 1 instrument.

To lubricate the propeller bearings a single-cylinder diesel fuel injection pump was used. This supplied a light mineral oil (OM-13) through a ceramic filter, sight glass and p.v.c. tubing to the oil supply tube of the indicator. The output of the pump could be adjusted as required. The changes in capacitance as the propeller revolved were measured by a Fielden proximity meter type P.M.2.

The capacity of any two conducting members to store an electrical charge varies with the distance between the conductors, the area of the plates and the permittivity of the interposing medium. When the propeller revolved in a non-conducting fluid there was therefore a change in capacitance between the probe and the propeller, when one blade of the latter was directly opposite the probe and when the probe was directly opposite the space between the blades. Thus during one revolution of the propeller the capacity changed from maximum to minimum four times; this in turn showed on the meter as four complete period swings.

An Elcontrol type PSCS2 decatron counter, fitted with a suitable pulse-shaping circuit, was used to count the capacitance changes and was connected to the Fielden proximity meter by a short length of co-axial cable. This counter was only necessary for the higher speeds, when the swings of the meter needle were too fast to be counted visually.

Experience with the Mark 2 indicator showed that with a fluid of constant viscosity there existed a straight-line relationship between the speed of rotation of the propeller and the relative speed of the fluid; also that the slope of the above line changed with viscosity of the fluid. While generally more satisfactory than the Mark 1 instrument, the Mark 2 suffered from some disadvantages. The proximity meter required tuning, which could be accomplished only with the velocity indicator immersed in the fluid, which had to be non-conducting.

THE DEVELOPED INSTRUMENT

A sectional view of the Mark 3 instrument is shown in Fig. 2. The propeller was made of mild steel and machined as for the Mark 2

* Dedow, H. R., and King, R. F. J., " Miniature Liquid Flow Meter," ENGINEERING, vol. 178, 1954, p. 396.

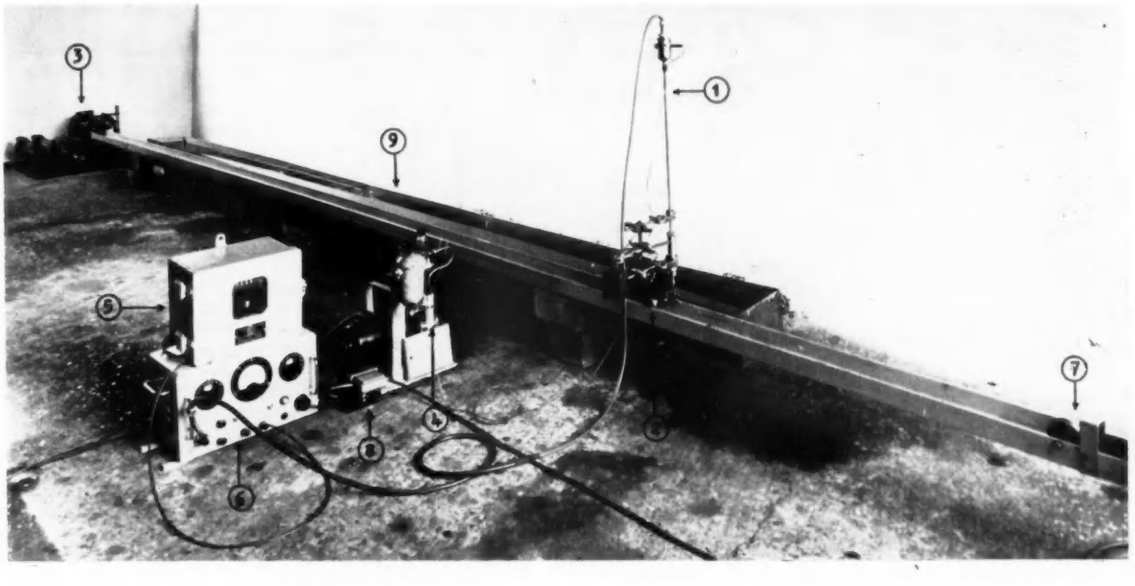


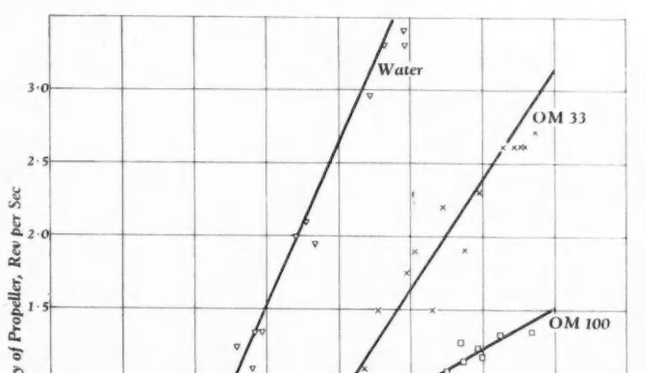
Fig. 4 Layout of the calibration rig.
(1) Velocity indicator.
(2) Trolley.
(3) Trolley propulsion unit.
(4) Lubrication pump.
(5) Decatron counter.
(6) Proximity meter.
(7) Trolley speed cam.
(8) Trolley speed counter.
(9) Tank.

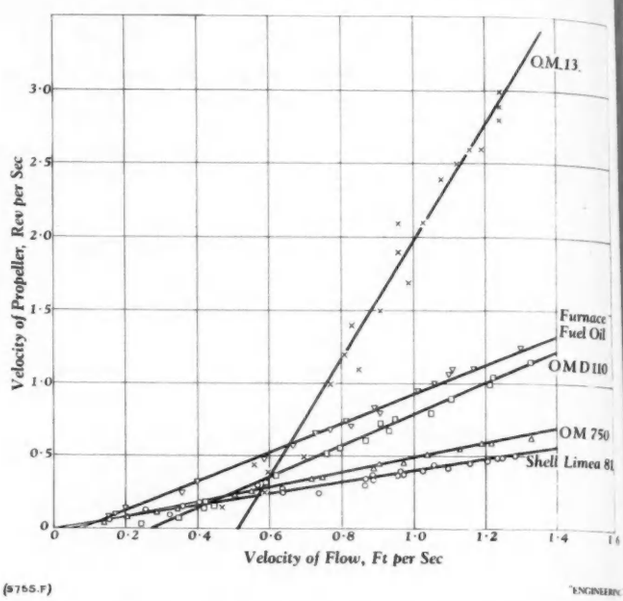
Continuing **Research and Development**

instrument, but a separate silver steel shaft was used. The propeller was mounted in two 4 mm by 1 mm by 1½ mm ball bearings and a rectangular flange fitted to the shaft between the bearings. The bearings were fitted into caps which were pressed into the housing. In order to keep the housing as small as possible the $\frac{1}{16}$ in bore pipe used for supplying the oil to the bearings was also used as one capacitance electrode; the oil supply pipe was suitably screened and insulated from the outer tube which formed the earthed electrode of the capacitor.

The propeller bearing housing was again connected to a $\frac{3}{8}$ in o.d. tube suitably fitted for the connection of the proximity meter as in the Mark 2 design. A similar gland to that used previously was provided.

The lubricant was supplied to the instrument using the same pump assembly as in the Mark 2. The lubricating oil now formed the dielectric of the capacitor irrespective of the fluid in which the propeller revolved. This had the advantage of allowing the proximity meter to be tuned before the insertion of the indicator in the pipe. It was also possible to use the instrument in conducting and non-conducting fluids. The heads of all three types of indicators are shown together in Fig. 3. The advantage of the Mark 3 over its predecessors, in causing the minimum obstruction to the flow pattern, is apparent.





Figs 5 and 6 Calibration curves for the Mark 3 velocity indicator.

CALIBRATION

To test and calibrate the instruments a special tank 15 ft by 1 ft by 9 in was manufactured. This tank was filled with the calibration fluids. The general layout is shown in Fig. 4. For the purposes of calibration the indicator was moved past the oil, rather than vice versa as is the case in the pipe. A trolley was made to hold the velocity indicator (item 2 in Fig. 4); this trolley was moved along a track adjacent to the tank by a cable moving over loose pulleys and operated by a variable-speed d.c. motor. A hexagonal cam was fixed to one of the loose pulleys and the cam follower operated a micro-switch in circuit with a counter. The speed of the trolley was thus easily and accurately determined with the aid of a stop-watch.

The Mark 3 instrument was calibrated with the following fluids: Shell Limea Oil 81; OM-1300, OM-750, OM-270, OM-100, OM-33, OM-13, OMD-110, water and furnace fuel oil, details of which are given in Table I. The results are given in Figs. 5 and 6. The relationship between the velocity of the flow and the velocity of the propeller was linear in all cases. However, the curves did not pass through the origin but gave an intercept on the flow axis. Finally, the relationship between the kinematic viscosity of the fluid (at calibration temperature) was compared with the effective pitch of the propeller. A tentative logarithmic relationship was indicated for the various oils but further work is required before any reliable relationship can be quoted.

It can be seen that the Mark 3 instrument is capable of indicating the currents in oils over a wide range of viscosity. It has also been shown to be capable of working in water.

TABLE I.—*Details of Fluids Used for Calibration*

Fluid	Calibration temperature, °F	Calibration viscosity, centistokes	Effective pitch of propeller, ft per rev.
Shell Limea Oil 81 ..	76·5	5,800	2·53
OM-1300	61	8,500	2·40
OM-750	69	2,600	1·96
OM-270	58	1,200	1·49
Furnace Fuel Oil ..	54	420	1·02
OMD-110	60·5	420	0·94
OM-100	64	320	0·79
OM-33	75	67	0·27
OM-13	73	24	0·25
Water	64·5	1	0·19

ACKNOWLEDGMENTS

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EXHIBITION OF SCIENTIFIC RESEARCH

Research is to be the key of the International Scientific Research Exhibition (ISRE) which is to be staged at Olympia, London, from 3 to 10 October, 1959. The exhibition, to which industry and research organisations are invited to contribute, is intended to focus attention on scientific achievement, and to provide a practical demonstration to the public of the tremendous benefits accruing from technical and scientific resources. The organisers are ISRE Ltd.

The exhibition has been carefully planned to reflect achievements in fields which directly or indirectly affect our well-being and everyday life, grouped for convenience, as follows: power and industry, materials, transport and communications, health and food. It is intended that the central aisle of Olympia will act as the lifeline of the exhibition and will be called the Avenue of Discovery. Bordering the Avenue will be the hard core of basic research—the university laboratories, co-operative research associations and the laboratories of industry. From any point along the central avenue the visitor will be able to trace the progress of development, stage by stage, of important products arising from research items selected. For example, if the pure research concerns polymers it would be possible, as one moves out towards the periphery of the ground floor plan, to trace the development of plastics and man-made fibres leading to a variety of products.

Special advisory panels, consisting of some of the leading scientists, designers and industrialists in the country, have been set up to be responsible for the impartiality of the selection of themes and the authenticity of the displays. France, Germany and the United States will also be invited to demonstrate their progress in technical and scientific research.

In the gallery at Olympia space will be reserved for firms manufacturing laboratory equipment and all kinds of scientific instruments.

Another interesting feature of the exhibition is the programme of special scientific films and lectures which will be presented in the Pillar Hall Theatre. A wide range of subjects will be included and there will be something of interest for visitors of all ages and backgrounds. Special bulk bookings at reduced fees are being arranged for school and university students. Further details may be obtained from ISRE, Oswaldestre House, Norfolk Street, London, W.C.2.

NEW LAMPS FOR OLD

Work in Progress at the Osram Laboratory

A new laboratory for development work on incandescent lamps is now operating at the Osram Lamp Works, Wembley, Middlesex. The laboratory combines facilities that have hitherto been located at Wembley and Hammersmith. Basic research on light sources is carried out by the adjacent Research Laboratories of the General Electric Company Limited. The task of the Osram Lamp Development Laboratory is to evolve a design of lamp having higher efficiencies than at present and that can be produced in large numbers. It is one of four laboratories concerned with the development of Osram lamps and tubes and their components. With a staff of 34, it occupies a floor area of 6,500 sq. ft.

In addition to developing new lamps for general use, the laboratory designs limited numbers for special applications. Recent products of the laboratory are miniature Christmas decoration lights, new spotlights for theatre lighting, an improved fuse for general service lamps, quartz lamps for aircraft and missile research and for underwater television lighting, and a new reflector projector lamp. The development of mass manufacture techniques is also an important part of the laboratory's work. Some current projects are described below.

Quartz Envelope Light Sources.—Work now being undertaken by the research laboratories and the development laboratories may lead to the marketing of incandescent light sources attainable for a specified lamp and rating. The lamps are derived from the tubular quartz-envelope infra-red heaters.

A particular advantage of quartz is its ability to withstand high operating temperatures and its resistance to thermal shock. Also the use of such an envelope makes a more compact construction possible. Preliminary work is being done on tubes of about 0·5 in diameter and with lengths of between 6 and 12 in, and several advantages accrue from this form of construction when use is made of the inhibiting effect of iodine on the evaporation of tungsten. One of the most serious obstacles in the development of high efficiency light sources has been the rapid evaporation of tungsten from a particular point on the incandescent filament: iodine reduces the amount of metal lost by evaporation and so promises to allow the attainment of much higher efficiencies.

Although the mechanism of operation is complicated, the iodine appears to combine with the vaporised tungsten present near the filament. The process is reversed at the much higher temperatures in the immediate vicinity of the filament: the tungsten is released and returns to the parent metal. Optimum operating conditions for the iodine carrier include the need for a short path length from bulb wall to filament and a comparatively high bulb temperature (of the order 300 to 400° C). Both conditions are fulfilled in the new tubular light sources.

Considerable research and development work has still to be undertaken and it may be several years, say the company, before the high efficiency tungsten filament quartz light sources become available. At present, investigations are in progress on high power lamps in the range 300 to 1,500 W. An experimental under-water hand lamp using a 1 kW quartz tubular lamp is shown in the illustration.

Fig. 1 The excellent thermal properties of the quartz envelope enable a compact construction to be achieved in this 1 kW underwater lamp.

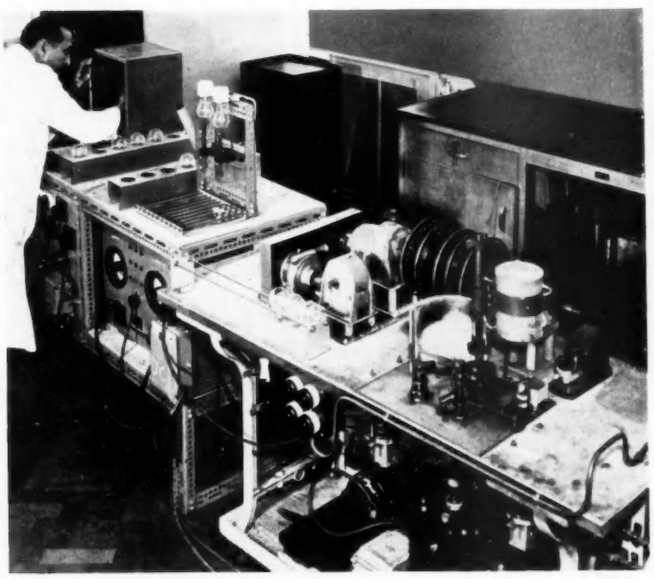


Fig. 2 The effect of variations introduced at the different stages of mass manufacture can be investigated with this equipment.

Studying Mass Manufacture.—The laboratory is continually investigating methods of mass manufacture. But as experiments on the mass production plant in the factories are undesirable, the laboratory carries out investigations on a machine which combines every manufacturing process on one lamp at a time. Thus it includes a standard filament and pinch assembly mounting device; a sealing-in machine on which variations can be made in the time and temperature cycle that the glass pinch assembly and lamp envelope undergo in production; and an exhausting machine in which the vacuum and gas supplies to the lamp are controlled by electro-magnetic vacuum valves operated in sequence by a camshaft. By varying the speed of the camshaft and the settings of the cams, any exhaust cycle can be reproduced and the effects of speed variations or exhaust schedule adjustments can be explored. The equipment used is shown in Fig. 2.

Reflector Projector.—A screen illumination from a 50 W lamp equivalent to the normal illumination obtained from a high voltage 500 W projector lamp is claimed for an 8 V lamp incorporating a ellipsoidal reflector. The lamp is shown in Fig. 3. The front surface of the bulb is spherical, and by arranging the filament at one focus of the elliptical reflector and positioning the " gate " of the 8 mm cine-projector at the other focus, the need for a backing mirror and condenser lens system is eliminated. The small size of the light source (low voltage), the larger pick-up angle, and the reduction in the number of transmission losses at glass-air interfaces, all contribute to the higher screen illumination achieved with this form of lamp.

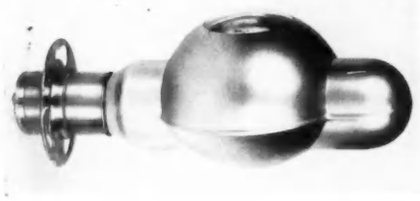


Fig. 3 In this projector lamp the integral ellipsoidal mirror behind the filament replaces the conventional separate backing mirror and condenser lens.

Vibration and Shock.—During the life of a lamp, changes occur in the crystalline structure of its filament. A good performance under vibration depends partly on the correct treatment of the tungsten powder during the early stages of manufacture and also on the method by which the filament is supported. Investigations into the effects of vibration on typical lamps are carried out by coupling them to an electro-magnetic transducer driven by a variable frequency oscillator. The filament is then viewed under stroboscopic illumination. A frequency range between 10 and 10,000 c/s is explored and the accelerations produced during vibration can be as high as 50 *g*.

For shock testing, a lamp is mounted in a cradle and dropped on to a hardened steel plate. Repeated shocks of this nature, under careful control of amplitude and frequency, determine the extent of the lamp's life. During the test the electrical characteristics of the lamp are recorded, and an indication of the behaviour of the filament and the amount of its deterioration as the bumping proceeds can be deduced from the measurements.

One outcome of these studies has been the development of a new rough-service lamp. In the past, the company usually provided a two-tier filament with 18 supports for their rough-service lamps. This form of construction was too complicated to permit the lamps to be mass produced and the filaments had been mounted by hand. However, the work carried out on vibration and shock testing has enabled the development of a simple, " single wreath " design of filament that uses only nine supports without loss of robustness.

Design

Around the BOAT SHOW

Now in its fifth year, the National Boat Show at Olympia (31 December–10 January) is one of the most popular of the annual exhibitions. Organised by the Ship and Boat Builders' National Federation, and sponsored by the *Daily Express*, it is said this year to be the biggest boat show in Europe. We give below a short survey of a few of the interesting designs seen.

The Boat Show is not confined to boats but covers all forms of water recreation from fishing to submarine exploration. Boats, however, are the principal feature, from the £10 " do-it-yourself " dinghy to the 11 ton ocean racer Meon Maid II and the luxury twin-screw coastal cruiser Dolphin Clipper. Taking a general look round, an increasing trend towards the use of man-made materials is noticeable. This year there are in evidence still more hulls either moulded or sheathed in resin-bonded glass fibre, and they are looking better and less like bath tubs than they did last year. The principal advantage of the reinforced plastics hull is the much reduced maintenance work and its easy repairability. Terylene is becoming an increasingly popular fabric for sails, ropes, life rafts and inflatable jackets on account of its properties of endurance, low stretch and stability.

The Alpha class sailing dinghy, illustrated alongside and shown by Bossoms Boatyard, Oxford, is claimed to be the " first thoroughbred racing dinghy specially designed for glass fibre construction." The hull designer is Mr. Ian Proctor, and the stiff, lightweight construction was devised by Mr. Stuart Wilson of the Engineering Laboratory, University of Oxford. The hull is in two main mouldings: the hull proper, and the decks and cockpit which form a one-piece moulding, the space between the skins being filled with a rigid plastics foam providing both stiffness and buoyancy. The boat is said to be unsinkable. The dimensions are: length overall, 12 ft 1 in, moulded, 12 ft; beam overall, 5 ft 0½ in, moulded, 4 ft 9¼ in; mast height above water, 20 ft 3 in; main sail area, 64 sq. ft, jib sail area, 26 sq. ft.

The Alpha class 12 ft dinghy is claimed to be the first thoroughbred racing dinghy specially designed for glass-fibre construction.

An interesting recent development in the yachting world, which is likely to be reflected in the whole future development of sports boats, was the formation some four years ago of the Amateur Yacht Research Society, " to encourage the design and construction of all kinds of experimental craft, whether propelled by wind, power or human agency; to improve and promote the invention of any kind of yachting equipment or accessory; to build up a pool of technical information on marine subjects . . ." This lively body of enthusiasts (not in fact confined to amateurs) has members all over the world, and is encouraging active yachtsmen to carry out research for themselves. They are particularly interested in multi-hulled boats, hydrofoils, " wingsails " and aerofoils, and every two months they issue a publication dealing with some forward-looking aspect of sailing technique. Among their publications now in course of preparation are booklets on glass fibre, yacht electrics, sail rigs, and cruising catamarans. In time they hope to acquire a wind tunnel, a test tank and a library.

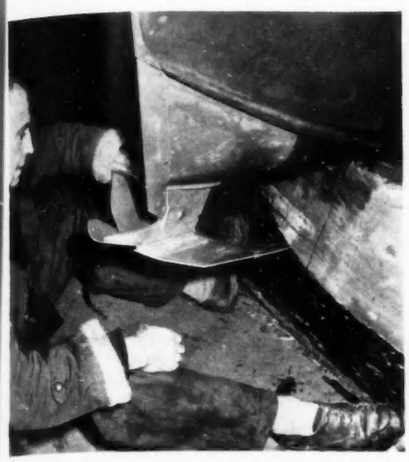
The trimaran configuration, that is a main hull and two outriggers, " can be the fastest craft of all for a given cost," say the Amateur Yacht Research Society. One example of this type of boat, seen for the first time at Olympia, was the 12 ft Trimaran built by Peter Webster Limited, Barnsley, Yorkshire, shown in the " boating-on-a-budget " stand. Here again the hull and outriggers are of resin-bonded glass fibre construction, the decking of marine ply.

The compact Katamar inboard runabout has a reinforced plastics hull and is powered by a 4½ h.p. engine.

Catamarans, combining speed with safety, are becoming increasingly popular, especially where there are children to consider. Kitboats of Harlow showed two " do-it-yourself " catamarans, both designed by Mr. Eric Parkin—the Firecrest, a small lightweight catamaran suitable for children, length overall 7 ft 8 in, beam 4 ft 6 in, sail area 36 sq. ft, weighing only 90 lb and transportable on the car roof. The Scimitar is a larger fast family boat, length overall 12 ft 4 in, beam 6 ft 3 in, sail area 70 sq. ft main, 33 sq. ft fore, weighing 165 lb, and transportable by road trailer.

An up-to-the-minute small inboard runabout (but not cheap) is the Katamar, shown in the illustration alongside, designed by Bianchi of Milan and shown by Katamar, 121-3 Edgware Road, London, W.2. A compact twin-hull design of polyester/glass-fibre construction, it carries four adults. Powered by a 4½ h.p. two-stroke engine, the Katamar has a cruising duration of about 3 hours, and a maximum speed of 12 knots. With an overall length of 10 ft 4 in, a beam of 4 ft 3 in, and weighing 225 lb, it can be transported on the car roof.

A recent development for improving the performance and riding qualities of runabouts and high-speed motor boats in rough water is the prototype Skie stabiliser designed by Mr.



Brian Grimston and shown by Mansell and Fisher 93-95 Old Brompton Road, London, S.W.7. As shown in the illustration, it is a simple and inexpensive variable-incidence hydrofoil which is fitted at the forward end of the hull. It was recently successfully tested on a 16 ft motor boat. The Skie stabiliser consists of a pivoted main vane whose centre of pressure is astern of the pivot. At the forward end of the main vane is a pilot vane which, in calm water, is clear of the surface while the main vane planes at an incidence of $1\frac{1}{2}°$. In rough water, on a rising wave gradient the pressure on the pilot vane causes it to tilt the stabiliser to increase lift; and as the wave gradient decreases, so does the stabiliser lift. Thus pitching is reduced and porpoising is eliminated. The stabiliser also reduces impact and pounding on the hull from floating logs and other debris. Moreover, it improves performance, reducing the wetted surface by up to 40 per cent. On a light motor launch, it is claimed, speed and economy can be increased with the Skie stabiliser by at least 20 per cent. It is not yet in production, but the designer considers that a stabiliser for a 26 ft boat should cost no more than £16.

Another device for improving performance and riding qualities was seen on the first hydrofoil craft to be displayed at the Boat Show. This is of American origin, shown by Avica Marine Division of Avica Equipment Limited, 50 Pall Mall, London, S.W.1. They are making, under licence from Dynamic Developments, Inc. (an affiliate of Grumman Aircraft Engineering Corporation, USA), the Seawings hydrofoil attachment for 14-16 ft outboard motor boats. Seawings are retractable aluminium hydrofoils, the main foils being mounted just forward of the boat's centre of gravity, and smaller tail foils at the stern. This arrangement, it is claimed, in addition to raising the speed of the boat, provides inherent stability and quick damping in rough water, and excellent manoeuvrability at high speeds. The boat on view at Olympia, and shown in the illustration below, was a 16 ft Grumman aluminium runabout with a 35 h.p. engine. It has, without the foils, a top speed of about 30 m.p.h. On the prototype foils (which are of glass fibre), with the hull clear of water and waves, the boat can achieve 40 m.p.h.

Hitherto, " do-it-yourself " boat builders have been more or less restricted to the hard chine type of craft, but now there are several kits available for the construction of round bilge designs. The Plycraft 14 ft Mercury one-design sailing dinghy, and the Kitboat 15 ft outboard runabout, both incorporate prefabricated round bilge sections in the kit, whereas the 14 ft Pegasus one-class sailing dinghy designed by Mr. Uffa Fox and shown by the Bell Woodworking Company Limited, makes use of a new type of plywood which can be formed without hot moulding. Bell diagonal marine ply, as it is known, has been developed by Thames Plywood Manufacturers Limited, Barking, Essex, and derives its flexibility from the use of diagonal outer plies on a straight core ply.

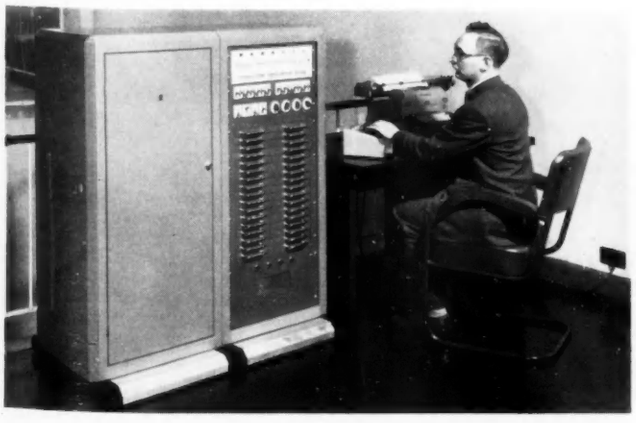
Turning now to sub-surface craft: the first British underwater tug was shown by Tough Brothers Limited, Teddington. Known as the Sub-Aqua-Jet, it is capable of towing a number of free divers, and has been tested to 100 ft below. Its main application is likely to be for search purposes when it is desired to cover as large an area of the seabed as possible in the time available. The Sub-Aqua-Jet is not, in fact, a jet, but a propeller-driven towing device, hand-held by the underwater swimmer, and readily manoeuvred by movements of the swimmer's body. The glass-fibre hull is divided into two air-tight compartments, the forward one containing one or two 12 volt batteries, and the rear one containing a 12 volt CAV motor which drives a pusher propeller. The single battery version has a speed of about 2 knots and a duration of about an hour. With two batteries a speed of about 3 knots and a duration of about two hours can be obtained. There is provision for mounting a camera, flash and spotlights, power for which can be taken from the battery. The tug is 3 ft 3 in long, 12 in in diameter, and weighs 85 lb.

The Skie stabiliser for light launches improves performance and reduces pitching and pounding in rough water.

Seawings hydrofoils fitted on a Grumman runabout. They are made under licence in Britain by Avica Equipment Limited.

The largest vessel in the show, the motor yacht Bevinda, is said to be the biggest plastics-hulled boat in the world; with a displacement of 15·75 tons, she is 56 ft long, 15 ft 6 in in beam and has a draught of 3 ft 9 in. Two 155 h.p., six cylinder Mercedes-Benz OM326 diesel engines power the Bevinda, which has a speed of 17 knots. The hull is displayed by the moulders, Halmatic Limited, Portsmouth, and is in Deborine glass-fibre laminate, with integral fuel tanks and engine foundations. The yacht is fitted out by James Taylor (Shipbuilders) Limited.

ROBUST COMPUTER FOR INDUSTRIAL CONTROL



A transistorised digital computer designed to provide automatic control of industrial processes is being developed by Ferranti Limited, Hollinwood, Lancashire. It measures about 4 ft by 4 ft by 2 ft. At the present prototype stage it is known as the PCTC (process control transistor computer); an experimental model has controlled a machine, simulating a plant process, for more than 2,000 hours. In addition, vibration and temperature tests have also been carried out.

The computer is being developed as the centre unit in control systems for a variety of industrial processes, such as may be found in the power, chemical, and steel industries. Babcock and Wilcox Limited and their associates Bailey Meters and Controls Limited, are currently investigating with Ferranti Limited the feasibility of using the PCTC for the control of boilers during start-up and shut-down. The computer does not require regular shut down for preventative maintenance.

The transistorised process control computer has been designed as a robust unit suitable for continuous running in industrial conditions.

Continuing **Design**

SAFE LOW ALTITUDE HOVERING

The Kolibrie Twin Ram-Jet Helicopter

A Kolibrie helicopter landing on its Helicar trailer.

A low-cost lightweight helicopter that has been designed to minimise danger in the event of engine failure is now being distributed in the United Kingdom by European Helicopters Limited, The Airport, Ipswich, Suffolk. The Kolibrie, as it is called, is of Dutch origin, developed by Nederlandse Helicopter Industrie, Rotterdam. It is reaction-driven by ram-jets at the tips of the two rotor blades. The tail rotor serves only for directional control.

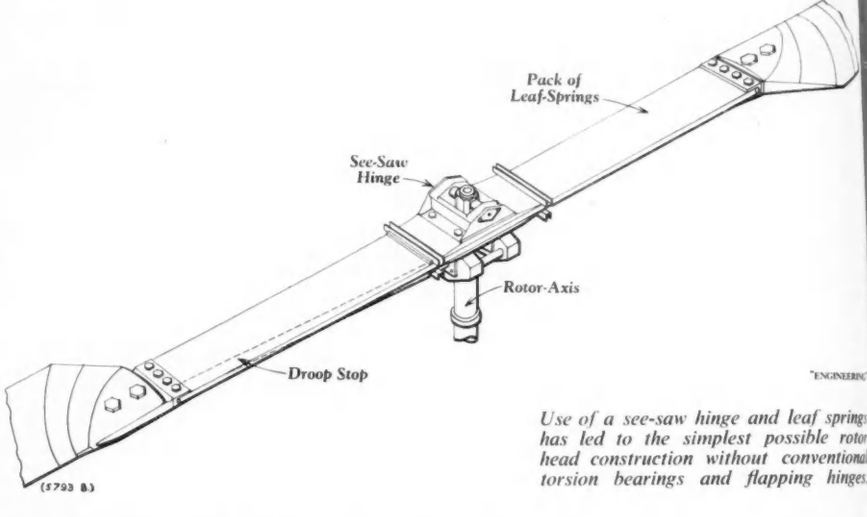
The importers, European Helicopters, are primarily concerned with crop-spraying, and it was for this purpose that the Kolibrie aroused their interest. However, realising that its low first cost, simplicity and inherent safety make it equally attractive for many other short-range applications, such as rescue work, fire-fighting, police duties, power-transmission line inspection, and engineering contractors' work, they are making it available for the British market.

The Kolibrie's ability to operate safely at low altitude is perhaps its most interesting design feature. With most helicopters operating today, should complete engine failure occur, it is necessary for the pilot to change the collective blade pitch of the rotor within 1 second to bring it into the autorotative condition; and if the failure occurs below, say, 300 ft, it may be disastrous. In the Kolibrie, owing to its high rotor inertia, the pilot has some 10 seconds in which to achieve autorotation and therefore, it is claimed, unsafe altitudes do not exist.

The two-blade 33 ft diameter rotor of the Kolibrie has been made considerably larger and four times heavier than conventional rotors in the same class, and it operates at the much higher rotational speed of 400 r.p.m. It has some 12 times more kinetic energy in the rotor for emergencies, and for rapid manoeuvres. This latter factor is a considerable asset during crop-spraying at ground level, enabling the pilot to hop over unexpected obstacles.

Another claim for the Kolibrie is inherent stability without loss of manoeuvrability, achieved by a self-adjusting rotor system. The blades are designed with the centre of gravity ahead of the lift centre so that the air loads tend to reduce the angle of attack and neutralise disturbances. Use of a see-saw hinge, as shown in the diagram, and leaf springs has led to a simple rotor-head construction, without conventional torsion bearings and flapping hinges. A rigid tube between the blade roots acts as a droop-stop and forms a fulcrum about which the blade incidence is changed. The Redux-bonded light alloy construction of the blades has proved to be strong, smooth and completely insensitive to moisture.

The tip ram-jets were developed in close collaboration with the National Luchtvaart Laboratorium. They consist of a streamlined shell containing fuel jets, baffles and a low-tension igniter. Each ram-jet produces 60 e.h.p., and operates on household-grade kerosine. The fuel consumption is, of course, very high—some 50 gallons per hour per engine under cruising conditions. On the other hand, each engine weighs only 20 lb. Installation and replacement of the engines is very simple; they are secured by two bolts only, and the fuel lines and ignition circuits are automatically connected. Fuel is supplied by centrifugal force through pipelines running through the hollow extruded nose section of the blades. For safety reasons, each engine has a separate fuel system and a comprehensive warning system alerts the pilot when fuel supply is running low.



Use of a see-saw hinge and leaf springs has led to the simplest possible rotor head construction without conventional torsion bearings and flapping hinges.

An auxiliary power supply is of course necessary for bringing the rotor up to the operating speed of the ram-jets. An electrical fuel pump in the main tank provides fuel pressure for starting the jets, and a 2 h.p. two-stroke petrol engine is used to start the rotor. This engine can be either a separate ground unit, or it can be installed at the rear of the rotor pylon. Four 22 Imperial gallon tanks are mounted on the skid chassis.

In the crop-spraying version of the helicopter, two of these are fuel tanks and two are used for the spraying fluid, a rotary pump driven by a second 2 h.p. engine conveying the fluid to the spray boom. The latter, of stainless steel, braced with guy wires, is flexible and collapsible, and extends beyond the rotors. The pilot therefore need not worry when flying near trees, pylons or buildings because the flexible boom will strike the obstruction before the rotors. The nozzles are of a swirl type, with numbered discs, which give droplet sizes from 80 microns to 200 microns. They are staggered along the length of the boom in order to give the most efficient coverage possible. The Kolibrie, when used for agricultural purposes, is operated from a trailer called a Helicar. From this mobile base, which avoids using fuel unnecessarily, it makes all its spraying sorties. Raised on the trailer, free of mud or uneven ground, it can be safely refuelled by the ground crew without danger from the rotors.

The cost of the Kolibrie alone is £8,049 5*s*. Complete with spray gear, Helicar, accessories and spares it costs £13,900.

THE HELIX ADDS BRIGHTNESS

An instrument cathode ray tube using helical post-deflection acceleration has been introduced by Mullard Limited, Torrington Place, London, W.C.1. The tube (DH10-78) has a 4 in diameter flat screen and an overall length of 12 in. It uses electrostatic focusing and deflection, and is suitable for double symmetrical operation.

The post-deflection accelerator consists of a high-resistance coating applied in the form of a helix to the inside of the bulb. Unlike the normal, single-step accelerator, the helical electrode provides a continuous gradient of acceleration voltage: this minimises pattern distortion and a higher post deflection accelerator voltage can be used.

Thus pre-deflection acceleration may be kept low to ensure high sensitivity, while the final accelerating voltage may be made high to obtain maximum brightness. Under typical operating conditions, X and Y sensitivities of 30 and 10 V/cm can be achieved with a post-deflection voltage as high as 4 kV.

Management

COMPANIES IN THE COMMONWEALTH

With so much talk of the Free Trade Area and Common Market of Western Europe, it would be easy to forget that some notable British engineering firms have established themselves firmly in the Commonwealth. By so doing they are actively helping to create a pattern of working partnerships—among advanced and underdeveloped countries—which will go far to reduce the buffetings of international politics. The United Kingdom has a stake in the Commonwealth and, apart from purely commercial considerations, can contribute to the development of those countries, with the satisfaction of participating in new growths throughout the world. This is the third of a number of articles in which the present position and prospects of British engineering firms in the Commonwealth are examined. The previous two, published on 15 August and 19 December 1958, considered Hawker Siddeley and Oldam and Son Limited.

3—Ruston and Hornsby Limited

Ruston and Hornsby Limited celebrated their centenary last year. Together with their associates, Davey, Paxman Limited and Ruston-Bucyrus Limited, and the subsidiaries abroad, they employed a capital of some £13 million so that they rank as a medium sized group in the engineering industry. In the import field, sales are spread over a wide area including China, the Middle East and South America, but Commonwealth countries have always been important customers. While the group is particularly well known for its oil engines there are a number of other important activities, and a review of the range of interests may be helpful before the Commonwealth associations are considered.

Ruston vertical oil engines cover a range from 4 h.p. to 2,400 h.p. In the smaller and medium sizes these units are sold for incorporation in a variety of construction and road-making equipment such as compressors, excavators, cranes and concrete mixers. The larger size engines are used throughout the world for driving generators and for pumping. At the top end of the range, a large part of the business is for main and auxiliary marine drives. Ruston's are thought to supply about 50 per cent of marine auxiliary engines in this field on the home market, and in 1956 their marine production achieved a record of 140,000 h.p.

The V-form engines manufactured by Davey, Paxman are widely used for main line diesel and diesel-electric locomotives. The gradual movement away from steam by railway authorities throughout the world should help this side of the business to develop, but the group do not make main-line locomotives, only the engines. Works and main line shunting locomotives are, of course, a major product of the group. Since many of the locomotive-building groups now have formal arrangements with diesel engine manufacturers, Ruston's may find themselves at a disadvantage in this field in the future unless they, too, can form such an arrangement. Ruston's do, however, build shunting and general-duty diesel locomotives which are used throughout the world and this is an important outlet in the locomotive field where diesel traction has now proved its advantage over steam.

Ruston and Hornsby started to make gas-turbines about three years ago and so far two models have been produced, developing respectively 1,300 b.h.p. and 430 b.h.p. The group are recognised to be one of the most advanced manufacturers of this type of unit in the country and have now sold about 100 sets. It is believed that their development programme includes plans for some larger models. Turbines are ideal power plants where water is not available, where the waste heat can be used for steam raising and especially where gaseous fuel is at hand. A number of sets have been supplied to the Middle East and to Venezuelan oil companies where they work on natural gas which might otherwise be wasted.

The group have one of the largest boiler-making shops in Europe, making vertical and horizontal boilers. Their main product is an economic type with steaming rates up to 17,500 lb per hour. This type of boiler is not exported in large quantities however: overseas sales in 1955 for all manufacturers combined amounting to about £2,000,000 as against £7,500,000 for water-tube boilers.

Davey, Paxman are important producers of centrifugal pumps and chemical plant, especially pressure vessels and rotary vacuum filters. This last item is now attracting much more attention and they should be well placed to take advantage of any increased business, their equipment having been specified for use in pulp manufacturing plants for some years.

Ruston's have now formed a nuclear energy section and are pursuing various developments in this field. Since they already have interests in turbines and boilers they should be in a good position to exploit the use of small nuclear power sources when these become available. The first nuclear product is the NFB gas bearing circulator but the main development is the design of relatively small nuclear power stations of 5-25 MW in conjunction with J. L. Kier and Company Limited.

It follows from the brief review of the group's activities that their exports consist largely of diesel engines. Total United Kingdom exports of diesel engines in that year were £34·7 million, of which about 40 per cent went to Commonwealth countries; Ruston and Hornsby therefore hold a very large share of this market.

Ruston and Hornsby have a factory at Poona, having moved from Bombay two years ago to obtain room for expansion. At the moment, only a limited range of horizontal oil engines is made there. India's perennial balance of payments' problem and the policy of the Government to build up local manufactures and so reduce dependence on imports would suggest that if the Poona factory can be expanded to produce a wider range of engines and equipment, the Indian company might be well placed to take advantage of the current industrialisation programme. The demand for diesel engines of all sizes in India is considered to be 60,000 units per annum, but the local output will probably not exceed 21,000 units this year. Ruston and Hornsby were one of the first companies to erect a plant in India, but there are now six others, by far the largest being the Kirloskar Oil Engineers Limited, also at Poona. Proposals have been made for erecting seven more plants in India, one with a capacity of 6,000 units per annum, and two have the backing of German manufacturers. The majority of the local production is in sizes up to 30 h.p. and imports of engines below that size are prohibited. Engines above 30 h.p. are imported, the vast majority coming from the United Kingdom.

Since no large reserves of oil have yet been found in India and practically all requirements, including diesel fuel, must be imported the diesel engine could be said to have a limited appeal as compared, for example, with countries in the Middle East.

On the other hand, one of the first requirements in raising the standard of living in rural areas in underdeveloped countries is the provision of cheap and convenient sources of power, and until electricity, whether based on hydro-electric resources, coal or nuclear energy, can be made widely available, there is likely to be an increasing demand for diesel engines. The second requirement is water and Ruston's diesels have important outlets in irrigation schemes.

Indian railways are likely to invest in diesel engines and diesel-electric locomotives on a large scale eventually—but gradually, since the country possesses good supplies of cheap coal and the conventional steam engine has additional attractions in a country where shortage of even semi-skilled labour makes a technical innovation a hazardous undertaking.

Despite these limitations, the company's prospects in India would appear to be quite good. As domestic output is at the moment insufficient to meet demand, and imports are restricted, an expansion of the Poona plant can be expected.

In Australia the group have erected a substantial factory near Melbourne, but production at the moment is confined to spares for servicing imported engines and excavators. There are three manufacturers producing engines up to 70 b.h.p. for industrial uses, and some marine engines up to 3,300 b.h.p. have been made.

Some idea of the relative size of the local industry may be gained from the fact that they currently produce about 2,700 units with a value of £A500,000 whereas it is necessary to import a further 2,800 engines valued at about £A1·5 million. About 60 per cent of these imports are derived from the United Kingdom and 30 per cent from the United States.

Naturally, the majority of these imports are industrial engines above 70 h.p. and marine engines, two fields in which Rustons are specialists, and therefore they command a substantial share of the market.

While the local subsidiary is dependent on the import of engines to supply the home market its turnover will tend to be subject to rather violent fluctuations, due to restrictions imposed by the Government from time to time on import licences. If the Melbourne plant could undertake the manufacture of the larger units in which Ruston and Hornsby specialise at Lincoln, they might be able to attract considerable extra business, for there is a definite preference for British engines.

In the smaller size of engine, the company are likely to experience increasing competition not only from Germany but also because American companies have licensed a number of local manufacturers to produce engines which Australian users will obviously prefer to an imported unit. With continued if slightly unpredictable industrial expansion in Australia, there is likely to be a steady market for diesel engines. It is a phenomenon associated with modern industrial expansion (to judge from Western Europe and the United States) that it seems to promote a very rapid increase in the use of oil engines. There is, however, some indication that American diesels are preferred for railway use as they have been found to stand up better to the high ambient temperatures. General Motors Corporation have formed an

Continuing Ruston and Hornsby Limited

association with Clyde Engineering Company Limited of Sydney, to produce locomotives, and Ruston and Hornsby are likely to be at a disadvantage unless they can form a similar alliance with an Australian company. The group have already supplied two gas-turbine sets to the atomic weapons station in Central Australia and it is possible that this form of power unit could be popular in a country where water is so precious.

Labour costs in Australia are very high and there is an incentive to install mechanical plant and hence power plant. Ruston's must already hold a good share of the market and the case for undertaking local manufacture of engine components must therefore become increasingly attractive. The annual imports from the United Kingdom of engines over 300 b.h.p. have been about £300,000 for some years.

The high labour costs would have to be considered also from the point of view of the manufacturer since diesels can still probably be imported from England or Germany and sold more cheaply than the locally made product. While imports are restricted by quota the problem does not arise but if that should be removed the situation might be different.

Canada is dominated by United States manufacturers who have the advantage of large home sales to support their export efforts and a short haul to the market. Imports of diesel engines into Canada have recently been about $25 million per annum, of which the United States and Britain supplies approximately 85 per cent and 15 per cent respectively. Imports from other countries are negligible at the moment, although it is believed that Germany is beginning to enter the market. While the value of the imports from the United States is much greater, Britain and the United States in fact supplied a comparable number of units so that the British trade is largely confined to the smaller size of engine. The value of the local manufacture in Canada at about $3 million in 1955, is less than that of British imports.

Ruston's already have servicing facilities in Toronto but it is doubtful whether the cost of establishing manufacturing facilities would be justified in a market which is so widely scattered. The large centres of population in Canada are well supplied with hydro-electric power but the very large diesels can find outlets for power generation in areas of scattered population. The Canadian shipbuilding industry is small and makes mainly small craft. Gas-turbines would no doubt be of interest to the oil producing regions, but Ruston's might well prefer to enter this market, if its size began to justify it, by licensing a local manufacturer as they have already done in the United States with Clark Brothers.

Ruston and Hornsby are one of the largest manufacturers of diesel engines in the United Kingdom with a predominantly export trade. The fact that they have already established a strong position in the market for gas-turbines and have set up a nuclear energy division as well as having opened last year an impressive new research centre, indicates that they are well aware of the need to adjust their range of products to changing conditions. Their marketing problem is an interesting one and is not unlike that of some other oil engine manufacturers in this country. Practically the whole of their production is centred in this country and yet their biggest markets are in the Middle East, Australia, India and South Africa, with the possibility of developing one in China—the world's great "development" areas.

For some years before 1955, 85 per cent of their trade was accounted for by exports but in the last few years this figure has fallen to about 70 per cent. This demonstrates the significance of foreign competition, particularly from Germany. Many of the traditional markets are anxious to start up local manufacture and there is always the problem of import restrictions to upset calculations when exports form a large part of sales. In 1955, the Chairman stated that local manufacture had in the past proved to be uneconomical in many cases and could not continue unless protected by heavy duties or, as in the case of India, by a ban on imports of similar products. Because of the increasing costs in Britain, however, there was some evidence that it was becoming more economical than before to undertake manufacture abroad. This very interesting comment, while sounding a warning to British producers in general, suggests that companies like Ruston's might before long find it advantageous to establish a large centre of production in, say, India, South Africa or Australia. One of the largest export markets for their products is the Middle East and, although it would be difficult to justify the siting of a factory in this region, an expansion of the Indian company to supply a full range might help to retain markets in the Middle East and develop new ones in the Far East by satisfying their nationalistic and political feeling. Such a long-term policy, however, would require marketing enterprise and large amounts of capital. It might nevertheless be worth keeping in mind for the 1960's.

Metals and Materials

CERAMICS AND CERMETS

—the search for new high temperature materials

As the ability of many materials to maintain their strength at higher temperatures increases with increase in melting point, research workers have considered the usefulness of high melting point materials such as oxides, carbides, nitrides, borides, and silicides, and refractory metals such as chromium, molybdenum and niobium. Ceramics are characterised by inherent brittleness and high sensitivity to mechanical shock and often to thermal shock, but are highly resistant to erosion and generally to oxidation. Metals and alloys usually possess adequate ductility and mechanical shock resistance but lose their strength at lower temperatures than do ceramics. Considerable effort has been devoted, particularly in the United States, to developing ceramics and mixtures of ceramics and metals-cermets, in the hope that the latter may combine the high temperature strength of ceramics with the ductility of metals.

Work has been performed on the problem of the bonding in ceramics both on an atomic level and in the massive sense of bonding discrete particles together. A great advance in hard metal carbides was made when suitable binders were found and now similar principles are being used to find binders for the other ceramics—the borides and silicides. Perhaps the greatest demand on the binder is that the metal should be compatible with the ceramic, for in the absence of these being in equilibrium with one another at high temperatures, there is diffusion, perhaps dissolution, and certainly a change in properties of the aggregate.

The importance of atomic and massive bonding featured prominently in the symposium on the Powder Metallurgy of Ceramic-Metal Materials which was held on 16-17 December, 1958, by the Iron and Steel Institute and the Institute of Metals. Most of the remarks made in this review are taken from the six papers which were presented on that occasion, and which are listed at the conclusion of this article.

Robins considered the nature and effects of the atomic bonds which exist within the ceramic materials themselves. He maintains that until there exists an understanding of the internal workings of the molecular structure, the full potential strength and desirable properties which ceramics could offer will never be fully realised.

Kieffer and Benesovsky review the developments in the field of silicides and borides. On a commercial level over 300 tons of hard metal (mainly carbide) products are manufactured monthly, valued at about $15 million. The question arises whether the high melting point of pure borides and silicides can be developed along similar lines to the carbides—the greatest advance in which occurred on discovery of the contingency of "cementing" with bonding metals. For a more detailed discussion of bonding metals, the authors say that it is indispensable to understand the constitution of the systems and the physico-chemical properties of the resulting compounds. In their paper they present much information on the binary and ternary systems, and discuss the theory of cementing silicides and borides.

Perhaps one of the most interesting points they make is in the possible practical applications of ternary alloys of the system Me-Si-B, of which they made extensive studies. The excellent scaling resistance of some silicides, and the great hardness, high melting point and good corrosion resistance of various borides suggested the possibility of obtaining new materials by combination of the two. This seemed reasonable because the materials have similar structures. Although no systematic data on quatenary and will less on multi component systems of transition metal silico-borides with metal additions are available, high nickel multi-component alloys of the system Cr-Si-B-Ni are widely used as sprayed coatings and are characterised by great hardness, excellent wear resistance and good ductility. One such alloy is Colmonoy with composition Cr 18, Si 3·4, B 4·2, Ni 72 per cent with a balance of Fe and C. The authors with other workers, systematically produced alloys of the system Cr-Si-B with 5 or 10 at. per cent nickel or cobalt, and applied them as facings on iron by the powder spray process. Attack by liquid aluminium was particularly well withstood by coatings which in addition to 10 at. per cent nickel contained 60-70 at. per-cent chromium, 5-15 at. per cent silicon and 10-20 at. per cent boron. It was found, however, that even if the coating alloy was resistant, its durability was largely determined by the method of application such as surface preparation, spraying technique, preheating process and pre-oxidation.

Use of ceramics as thin coatings on more ductile base metals overcomes their main disadvantage of sensitivity to mechanical shock, but enables their good properties such as corrosion resistance to be utilised. There is, however, an advantage in producing massive ceramic parts and most current research is in fact directed towards this end.

The most widely used methods of fabricating massive ceramics or cermets are compacting and sintering or hot pressing. During the period at high temperature bonding occurs and it is the strength of this which largely determines the

strength and thermal characteristics of the resulting material.

Two types of bond between particles of ceramic and metal are recognised—chemical wetting and mechanical bonding. Consideration of the lattice energies and the ion sizes has allowed some theoretical prediction of the surface wetting and bonding, but in practice the predictions are seldom realised because of the high pressures and temperatures which prevail in the extrusion, forging processes or pressing process used in the manufacture of the material.

Wright, Gibbon and Williams describe practical experiences in manufacturing uranium oxide-iron cermets in rod form. Rolling proved to be an unsatisfactory process and although cermets containing up to 30 vol. per cent of oxide were produced, the core became distorted and the oxide particles were fragmented. Extrusion at 1,200° C allowed satisfactory fabrication of cermets containing up to 50 vol. per cent oxide. Properties of the rod were good and 90-95 per cent of the theoretical density in the oxide core was obtained.

Various methods of producing chromium-alumina and molybdenum-chromium-alumina cermets were described in a paper by Huffadine, Longland and Moore. The most desirable combination of metal and ceramic is where there is wetting, bonding, and the phases have the same expansion coefficients over a wide range of temperature. One possible combination is alumina and chromium since the metal forms an adherent oxide which forms a solid solution with alumina. However, in this instance, the metal and ceramic phases have different coefficients of expansion. With a reduction in oxidation resistance, the coefficients may be matched by use of 60 per cent Cr-Mo alloy. Because of the greater coefficient of the metal in Cr-alumina cermets with alumina as the continuous phase, the metal is in a state of tension after cooling with the result that the bond is almost certainly broken and thermal conductivity drops markedly. It may be that the superior room temperature modulus of rupture and impact strength of Mo-Cr-alumina as compared with Cr-alumina results from the minimisation of internal stresses. Although the aim in the work on such cermets has been to produce an improved gas-turbine material, applications have already been found in other fields. Since they are not wetted by alloys containing iron, copper, zinc, and lead, these cermets may be used for parts of casting equipment and for thermocouple protection tubes. Molybdenum-chromium-alumina has excellent wear resistance—superior to that of tungsten carbides under some conditions, and may be used for gauges, or in applications where resistance to wear under non-lubricated conditions is required.

Glenny and Taylor tested a range of massive materials at the National Gas Turbine Establishment at temperatures up to 1,200° C. The properties under test included creep strength, fatigue strength, resistance to thermal shock and to thermal fatigue (that is, to repeated thermal shock), resistance to oxidation and resistance to mechanical shock. A selection from the results of these workers is shown in the Table. It is interesting that they were able to alter the rate of heat transfer in thermal shock tests by making use of an air fluidised bed with variable air mass flow. Thermal shock resistance was assessed by determining the temperature difference ΔT_c that was just sufficient to cause failure by cracking or fracture.

Resistance to thermal fatigue was measured as the number of heating cycles N which the specimen endured before failure. As the authors say in their paper, it is apparent that all the brittle materials have thermal shock and thermal fatigue resistance considerably inferior to Nimonic 90. The highest impact strengths are shown by the metal-bonded carbides, but are only about 10 per cent of that of the casting alloy Nimonic 258. Unfortunately, the most creep resistant ceramics and cermets—the American self-bonded silicon carbide, and the most thermal shock resistant—fused silica and silicon nitride, have the lowest mechanical shock resistance.

Watt reported on the oxidation of zirconium and titanium carbides by high temperature combustion gases. Because of their melting points between 3,000 and 4,000° K the carbides of the transition elements are of interest as potential high temperature materials. In one such application, in the nozzle of an uncooled rocket, the material should withstand a temperature of around 2,400° C for 30 to 100 sec. The materials were subjected to a flame produced by burning a mixture of ammonia, acetylene and oxygen. The combination gases contained 22 per cent CO_2 and 45 per cent H_2O and attained a temperature of 2,400° C. Watt found that under these conditions zirconium carbide was oxidised but that a coating of zirconium dioxide was formed and the rate of oxidation decreased parabolically. Titanium carbide did not produce a film of oxide, as the temperature was above its melting point and the oxidation followed a linear law.

At the present stage of development it seems that none of the massive materials under review has a sufficiently good combination of properties, and the likelihood of their application has been reduced by recent advances in creep resistant wrought and cast alloys.

The development of ceramics and cermets is in no way ended, and with a better understanding of the atomic structure and of the bonding which exists between particles, it seems very probable that high strength materials, resistant to mechanical and thermal shock, will eventually emerge. Meanwhile, prospects of utilising ceramics and cermets in such applications as gas-turbine engines would be enhanced if design engineers were to find it possible to adapt their design to accommodate the stronger but more brittle materials that are being produced.

The papers presented at the symposium are published in *Powder Metallurgy*, 1958, No. 1/2.

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D. A. Robins: "Bonding in Carbides, Silicides, and Borides."
W. Watt: "The Oxidation of Zirconium Carbide in High Temperature Combustion Gases."
E. Glenny and T. A. Taylor: "The High Temperature Properties of Ceramics and Cermets."

Material	Bend		Bend-creep	Fatigue			Thermal shock and thermal fatigue (rapid cooling)*		Impact strength, ft-lb/sq. in	Method of manufacture
	Temp. °C	Bend tons/sq. in strength,	Time for stress of 2 tons/sq. in to give 0·125 per cent strain at 1,000° C (hrs.)	Temp. °C	Stress, tons/sq. in	Endurance cycles × 10^6	ΔT_c (T_1 = 20°C)	N (T_2 = 1,020°C, T_1 = 20°C)		
Sintered alumina	20 1,000	20·7 (6)† 6·75 (3)	650	1,000 1,000	10 12	204 (UF)§ 31·4 (F)	500 (5)†	—	1·60	Pressed and sintered in air
20 Cr-Al_2O_3	20 1,000	17·10 (3) 17·60 (1)	—	— —	— —	— —	325 (5)	—	1·11	Pressed and sintered *in vacuo*
40 Cr-Al_2O_3	— —	— —	—	— —	— —	— —	425 (6)	—	1·17	Pressed and sintered *in vacuo*
75 Cr-Al_2O_3	— —	— —	93	— —	— —	— —	1,000 (3) (UC)‡	2 (6)	—	Pressed and sintered in argon
79 Cr-Al_2O_3	20 —	20·50 (3) —	344	— —	— —	— —	1,000 (3) (UC)	305 (3)	—	Slip cast and sintered in hydrogen
35 Cr-35 Mo-Al_2O_3	— —	— —	—	— —	— —	— —	1,200 (1) (UC)	12 (2)	—	Hot pressed
56 Cr-14 Mo-Al_2O_3	— —	— —	—	— —	— —	— —	1,200 (1) (UC)	20 (6)	—	Hot pressed
SiN-SiC	20 1,100	4·70 (3) 3·30 (1)	> 300	1,200 1,200	1·0 2·0	132 (UF) 97·7 (F)	1,200 (2) (UC)	145 (2)	0·52	Si-bonded SiC fired in nitrogen
Self bonded SiC (I.C.)	20 1,100	4·85 (1) 6·00 (1)	—	1,200 1,200	1·0 2·0	73·9 (UF) 97·7 (F)	1,200 (2) UC)	137 (2)	0·58	Not known
Self bonded SiC (American)	20 1,200	10·60 (2) 13·60 (2)	—	1,200 1,200	6·0 8·0	193 (F) 107 (F)	1,200 (2) (UC)	230 (2)	0·82	Not known
40N TiC-Ni-Cr_3C_2	20 1,000	61·30 (3) 31·50 (1)	3·95	900 900	12 15	107 (F) 6·24 (F)	1,000 (3) (UC)	43 (3)	6·75	Pressed and sintered *in vacuo*
Si_3N_4 (1)	— —	— —	45·5	— —	— —	— —	1,200 (1) (UC)	1,430 (2)	0·40	Pressed silicon skeleton nitrided
Si_3N_4 (2)	— —	— —	> 300	— —	— —	— —	1,200 (1) (UC)	55 (2)	0·53	Pressed silicon skeleton nitrided
$MoSi_2$	20 1,000	22·8 (3) 15·10 (1)	66·5	— —	— —	— —	—	2 (3)	0·86	Hot pressed
Nimonic 90	— —	— —	—	— —	— —	— —	1,000 (3) (UC)	700 (2)	—	Wrought
Nimonic 95	— —	— —	4·4	— —	— —	— —	1,000 (3) (UC)	640 (3)	—	Wrought
Nimocast 258	20 —	83·40 (3) —	100·0	— —	— —	— —	—	—	69·5	Cast and remelted in air

† Number in parentheses indicates number of tests F = Failure § UF = Test discontinued before failure * Heat transfer coefficient 0·040 chu/sq. ft sec °C. ‡ UC = Uncracked

Book Reviews

REQUIRED RESPONSE

Network Synthesis. Vol. I. By DAVID F. TUTTLE, JR. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, N.Y., USA* ($23·50); and *Chapman and Hall Limited, 37 Essex Street, London, W.C.2.* (188*s*)

Synthesis of Passive Networks. By ERNST A. GUILLEMIN. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, N.Y., USA* ($15); and *Chapman and Hall Limited, 37 Essex Street, London, W.C.2.* (120*s*)

Any passive circuit which contains resistors, capacitors, or inductors, or any two or all three of these types of element is a network. It may form the anode load of a valve in an electronic circuit; or act as an equaliser in a telephone line; or have a complex transmission factor in a computer or simulator. The input signal to a network is usually an alternating current of varying frequency, and the output signal is an alternating voltage or current of the same frequency. The relationship between the magnitudes of the input and output signals (the transmission factor) will vary with frequency according to the design of the network. The graph of transmission factor against frequency is the response curve. The network will present a certain impedance to the source of input signal and in the case of four terminal networks will also have an output impedance. The object of network syntheses is to create a network which has a given input and output impedance and a response curve identical with that theoretically required from the network. The two books which are the subject of this review investigate ways of approximating to the desired response and methods of realising the attainable results.

David F. Tuttle, Jr., took French and mathematics at Amherst College and studied for his D.Sc. at the Massachusetts Institute of Technology. At Bell Telephone Laboratories Incorporated, he designed, constructed and tested networks, gaining practice in network simulation. Since 1948 he has been Professor of Electrical Engineering at Stanford University and during that time he has lectured in France and Spain. His book, " Network Synthesis, Vol. I," has been written after teaching network synthesis for a number of years. It deals only with two terminal networks (Vol. II will cover four and more terminal systems) and is suitable for students who wish to make a specialist study of the subject. The book pre-supposes a sound knowledge of a.c. theory backed by mathematical ability to use complex numbers, matrices and operational calculus. A simple introduction clearly points the route along which the author intends to guide his reader. The book then proceeds to review briefly the properties of network elements and restates some of the classic theories on which network analysis is based. The conception of the complex frequency variable is explained in some detail to complete the collection of ideas required for examining the properties of networks.

It is not possible always to reproduce exactly the theoretically required properties in a practical network. To examine the theoretical properties and predict their realisation is the object of the next few chapters of the book. From a consideration of energy in networks, the concept of positive reality is developed which is an important criterion of realisation. This is followed by an analysis of the input impedance or admittance of the networks which gives rise to further conditions of realisation. These tests of realisation are put into action in the synthesis of networks containing two of the types of element only. The properties of the input impedance and admittance are then further examined before a lengthy section on the synthesis of realisable networks containing all three types of element.

At this stage there is a break in the book: a little lighter matter is introduced in the form of a section on practical applications. This is followed by another section on the practical difficulties of constructing realisable networks. These sections, while of great importance, provide easier reading than the main bulk of the book. The final chapters deal with methods of approximation where the theoretical properties of the network are not practically realisable. These include Padé's and Chebyshev's method together with others. A long account is given of the potential analogy method of approximate realisation. The book is well written and presented in a pleasant style which is for the most part easy to read. Each chapter concludes with a clear, concise summary and a number of problems. Liberal use has been made of worked examples to illustrate the various processes, and the whole book is amply illustrated. Well defined, clearly numbered sections, combined with an adequate index, make it very easy to refer to any section. There are three appendices. The first is mathematical and assists in the calculation of results. The second is a table of values of a function mentioned in the book. The third is an extensive bibliography with numerous references to British and European papers on the subject. If Vol. II lives up to the standard of Vol. I they should, together, take a student well into the realms of experimental network synthesis.

Ernst A. Guillemin received his BA in electrical engineering in 1922 from the University of Wisconsin and his MS in 1924 from the Massachusetts Institute of Technology. In 1926 he became doctor of physics and mathematics of Munich University and in the same year joined the Massachusetts Institute of Technology where he is now Professor of Electrical Communication.

He has written several earlier books, including *Mathematics of Circuit Analysis* and *Introductory Circuit Theory*. *Synthesis of Passive Networks*, the book under review, he regards as a continuation of these other volumes and " results given there are drawn upon freely, mostly without further comment."

It is not essential for a reader of this book to have read the previous two, but he must be familiar with the subject matter in them. This implies a knowledge of circuit analysis supported by a mathematical ability similar to that required for Tuttle's book. Guillemin studies two sides of network synthesis, namely, realisation and approximation. He does not deal with the properties of networks, where he assumes the reader's adequate knowledge.

The book commences with chapters on testing conditions for realisation, after which the driving point impedance of two-element type networks is examined. The general three-element type of network is then considered in detail, together with some discussion of properties of two terminal pair networks. The classical methods of driving point impedance synthesis of Brune and Darlington are presented, followed by the Bott and Duffin and the Miyata methods of realisation.

The next section of the book studies transfer-function synthesis and gives various classical procedures. It is followed by the final chapters on the subject of approximation. These include the use of Butterworth, Tschebyscheff, and eliptical functions, and many additional techniques needed to solve approximation problems.

The book is written in a fairly readable style and is amply illustrated. An adequate index, combined with section numbering makes it easy to find the required section. There are footnotes throughout the book which refer the reader to articles and other books on the subject, but there is no collected bibliography. Each chapter concludes with a number of problems. This book covers much more ground than Tuttle's, in fewer pages, and should be a useful work of reference. It is more suited to those who have a working knowledge of networks than those who wish to learn of them.

D. GRIFFIN

NEW BOOKS

Heenan Multiform Manual. By T. HANSON. *Wickman Limited, P.O. Box No. 44, Banner Lane, Tile Hill, Coventry.* (75*s*)

Described as unique, this book contains information on the use of four-slide automatic wire and strip-forming machines. The machines covered in the manual were designed by the author and are illustrated by numerous drawings and diagrams.

Geological Structures and Maps. By A. ROBERTS. Second Edition Enlarged. *Cleaver-Hume Press Limited, 31 Wright's Lane, Kensington, London, W.8.* (12*s* 6d)

The subtitle of this book (in spiral binding incidentally) is " A course in interpretation with applications for civil and mining engineers." The last 37 pages (of 92) consist of " maps and exercises."

Electric Technology USSR. Vol. 1, May, 1958. Selected papers from " Elektrichestvo " Nos. 1-4, 1957. *Pergamon Press Limited, 4 and 5 Fitzroy Square, London, W.1.* (120*s*)

The Russian journal of which this is a translation was one of the first three electrical engineering journals to be published anywhere in the world. Four volumes will appear each year at a subscription of £20.

Demountable Vacuum-Tight Pipe Coupling with Facilities for Remote Operation. By W. P. WHITE. *Her Majesty's Stationery Office, York House, Kingsway, W.C.2.* (3*s* 6*d*)

Where radioactive materials are being handled, demountable couplings for pipe lines carrying gases or liquid metals may have to be operated by remote controls passing through biological shields. This brochure by Mr. W. P. White, of the Research and Development Branch, Capenhurst, of the UKAEA (Industrial Group), describes a coupling for ½ in nominal bore pipe which meets the requirement stated and is of simple construction, being based on a modified three-jaw self-centring lathe chuck. The coupling has been tested and found to be satisfactory for lines carrying gases at up to 500° C, or liquid metals up to 300° C. It would probably be suitable for much higher temperatures and high pressures.

The brochure gives a description of the coupling, and the method of testing. Working drawings are provided. The coupling is potentially suitable for use with larger pipes.

Physical Basis for Electrical Engineering. By THOMAS L. MARTIN. *Macmillan and Company Limited St. Martin's Street, London, W.C.2.* (30*s*)

Described as providing a basis for electrical engineering courses at universities and technical colleges. It should be borne in mind that the author is a Professor at the University of Arizona.

The Empire and Commonwealth Year Book 1958-59. Edited by RONALD S. RUSSELL. Seventh Edition. *Newman Neame Limited, 50 Fitzroy Street, London, W.1.* (50*s*)

An invaluable reference book for those requiring information on any country in the Commonwealth. Population, trade, communications, industrial development, climate—all are dealt with and much else besides.

Directory of Railway Officials and Year Book 1958-59. *Tothill Press Limited, 33 Tothill Street, Westminster, London, S.W.1.* (40*s*)

Past users will know that the word " international " should be included in the title of this annual in its

ENERGY AND MATTER

Reports on Progress in Physics. Vol. XXI (1958). Edited by A. C. STICKLAND. *The Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.* (63*s*)

The titles of the nine reports contained in this volume illustrate the important part played by atomic and nuclear physics in present-day fundamental research. Thus, two reports deal specifically with the nucleus and two others with atoms or very small groups of atoms. These papers are largely theoretical in character, but in most cases the theoretical predictions are carefully compared with results obtained by recently-developed experimental techniques.

Crystal structure is dealt with under the headings " Absorption and Fluorescence Spectra of Ions in Crystals " and " Fourier Methods in Structure Analysis by Electron Diffraction." The former paper shows how the study of absorption and fluorescence spectra has led to rapid progress in the subject of energy levels of ions in solids, numerous examples being quoted. The second paper reviews electron diffraction techniques for the determination of crystal structure and describes methods based on the Fourier series which may be used in analysing electron diffraction spot patterns. In a final section the latest progress in direct observation of crystal structure using fast electrons is discussed. Some excellent photographs are reproduced, in which edge dislocations are clearly visible.

In a paper dealing with the specific heats of metals at low temperatures, a comprehensive review of the theoretical and experimental aspects of the subject is given. Distinction is made between the lattice specific heat, appropriate to the fixed atoms in the metal crystal, and the electronic specific heat, appropriate to the free electrons acting like a gas within the metal. Classical theory leads to the wrong value for the electronic specific heat and provides no explanation for the fact that the specific heat of metals decreases towards zero with decreasing temperature. The application of the quantum theory to both lattice and electronic specific heat problems is therefore detailed, with particular reference to such groups as the monovalent metals, divalent metals, transition metals, rare earths and superconductors. Finally, emphasis is laid on the need for more reliable data, particularly at temperatures below 1° K.

An excellent survey is given of the methods available for the production and measurement of high temperatures. The temperature range dealt with (10^1-10^6 °K), however, and the methods of measurement employed, are outside the scope of most engineering work of the present day. Nevertheless, if some of the most recent work bears fruit, it may be that more attention will need to be paid to the problems in future. The measurement of the high temperatures can usually be effected by observation of the intensity and shape of the spectral lines, or from the continuous radiation emitted by the hot gas. This work is fully discussed, after which such gas properties as viscosity, electrical and heat conductivity at high temperatures are described.

High temperatures may be produced by any one of the following methods: electric arc, pulsed discharge, exploding wire, plasma jets, shock waves and chemical reactions. Each of these methods is treated descriptively, with full reference to original work and to the limiting temperatures obtainable. Brief mention is made of the recently publicised work on pinched discharges in toroidal tubes, giving temperatures up to 5 by 10^6 °K, but the report echoes doubt about the origin of the neutrons frequently observed coming from deuterium-filled discharge tubes. The report is essentially factual, and possible consequences of this type of work are not discussed. Over 160 references are given.

The scope of the book is broadened by an interesting paper on the physics of nerve processes. " Reports on Progress in Physics " is of interest to those people or organisations who need to be kept in touch with the latest advances in physical research, a field which has more and more to give to the world of engineering.

D. R. OLIVER

Continuing NEW BOOKS

64th year. There are one or two innovations which should make this book of reference even more useful. It is refreshing to read of travel in the USSR other than by satellite or Tupolev.

The Federation of Civil Engineering Contractors Handbook, 1958-59. *Romney House, Tufton Street, Westminster, London, S.W.1*

As well as a list of members, together with one divided into the Federation's various geographical sections, the handbook includes such useful material as the main industrial agreements to which the Federation is a party.

Lighting in Corrosive, Flammable and Explosive Situations. IES Technical Report No. 1. *The Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.* (5*s*)

Durchflussmessung. Mitteilung Nr. 348a der Energie- und Betriebswirtschaftsstelle (Wärmestelle) des Vereins Deutscher Eisenhüttenleute. By M. HANSEN. *Verlag Stahleisen MBH, Postfach 2590, Breite Strasse 27, Dusseldorf, Germany.* (7 *DM*)

Master Plans for Integrated Water Utilization. By KANWAR SAIN. Reprinted from the *Journal of the Institution of Engineers* (India), Vol. XXXVIII, No. 7, Pt. 1, March 1958. *Government of India, Central Water and Power Commission, New Delhi.*

The Kestner Golden Jubilee Book. *The Kestner Evaporator and Engineering Company Limited, 5 Grosvenor Gardens, London, S.W.1.*

An Investigation of Transmission Length in Pretensioned Concrete. By G. D. BASE. Research Report No. 5. *Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.*

The Reviewers

Mr. D. Griffin is chief technical author with Solartron Research and Development Limited.

Dr. D. R. Oliver, who is lecturer in chemical engineering at the University of Birmingham, obtained his B.Sc. in physics and his Ph.D. in mining.

TRADE PUBLICATIONS

Compressed Air

Calculator. LANG PNEUMATIC LTD., Birmingham Road, Wolverhampton. Slide rule for use with the firm's " Pneumation " equipment; calculations of cylinder volume, stroke, force, and displacement can be carried out with allowance for temperature variations.

Hand Tools. B. O. MORRIS LTD., Morrisflex Works, Briton Road, Coventry. Hand pneumatic tools for grinding, polishing and drilling of metals. Also chippers and brushers. Brief list ZA1.

Drills. BROOM AND WADE LTD., High Wycombe, Buckinghamshire. " Par-A-Matic " self-feed air power units for production drilling and tapping. Both stationary and portable models; 500 to 17,000 r.p.m.; ¼ in chuck. Publication No. 443TE.

Air Control. BENTON AND STONE LTD., Aston Brook Street, Birmingham 6. Booklet describing the Enots series of products and giving standard symbols, etc. Also 20 min colour film showing applications.

On the Shelf

By Frank H. Smith

Here's another of those Library Association publications that do not come from Malet Place —A Select List of Periodicals in Yorkshire Libraries has been prepared by the Reference and Special Libraries Section, Yorkshire Group. It costs 6*s* from E. Wilkinson, Commercial Library, Hall Ings (sic), Bradford 1. First a list of abbreviations (e.g. Am stands for Ampleforth College), then the journals in abc order with the holders and their holdings. They do not tell me how many journals they cover but there are about 80 co-operating libraries (I counted them myself) of which 22 keep a file of the Journal With the Brightest Column in Technical Journalism Today.

Among the list of abbreviations the compilers omit a mysterious P. and T. and J. that appear in the list. Can they be Proceedings, Transactions, Journal?

A neat little contemporarily covered booklet comes from Shell-Mex and B.P. Limited (Shell-Mex House, W.C.2) entitled " film library catalogue 1958-9." Full details are given of how to borrow and convenient booking order slips are perforated at the back of the book. In fact Shell do everything for you bar project. Several new films are indicated by an asterisk, including FANTA, a road safety filmlet featuring Fanta the elephant. They say " this film can be satisfactorily used if attached temporarily to the tail of another film." But an elephant has such a silly little tail compared with the other end. Well, hasn't it?

If you have not already had it I suggest you write to LLU of DSIR (20 Chester Terrace, Regents Park, N.W.1) and get the circular about the PB reports they get from America. Whereas DSIR used to receive only about one-third of the PB series, they now get the lot and they are all available for loan and, in some cases, for retention. As those in the know will know, Science Library loan forms cover DSIR requests.

I get a bit confused with the various Dawson firms connected with journals but the William (and Sons Limited) variety of Cannon House, Macklin Street, London, W.C.2, issues a neat little " Guide to the Press of the World " now in its 57th edition, 120 pages of it, and it bears no price so I assume they do it out of the goodness of their hearts and to let you know that they can supply any of the thousands of journals and papers listed therein. It is divided into various sections—countries, annuals and miscellaneous, and the subscription rate appears alongside each item. Did you know the *Eagle* is 26*s* overseas as opposed to 28*s* 2*d* inland? I'm going to emigrate and get Dan Dare cheaper.

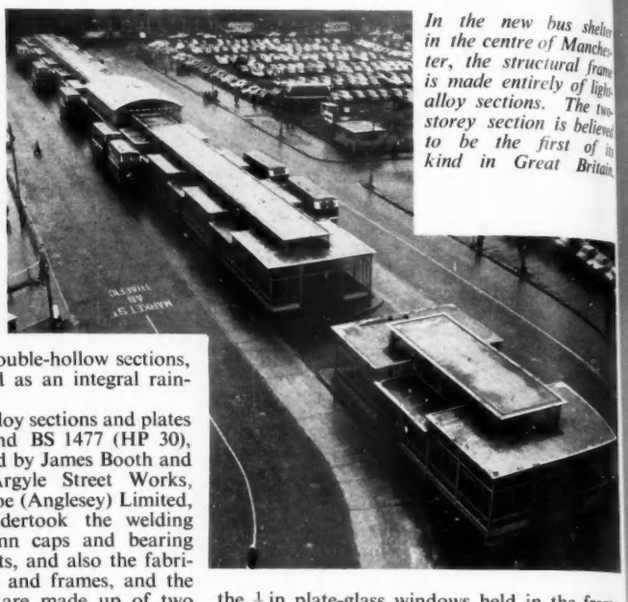
No. 91 of Volume 10 of the Reports of the Institute of High Speed Mechanics (Tohoku University) is entitled " Outline of the Institute of High Speed Mechanics." It gives the history of the Institute, describes its researches and details its economics. There is also a list of its publications, " Out of the fruits of researches of the Institute, those printed and published to the academic circle are enumerated hereunder classified by the year of their publication excluding theses on researches consigned by other sources," and if I could write Japanese half as well I should be proud. In fact, if I could write English half as well. . . .

Consultants Bureau Inc. (227 West 17th Street, New York 11) announce " Soviet Research in Glass and Ceramics—1956." $40 for 63 papers translated from the Russian. It looks as though the Americans have at last found something Russian that they can see through—unless it happens to be opaque glass.

The " Mechanicals " have " decided to issue a new publication " (their wording) to be called *Journal of Mechanical Engineering Science*. It is to be a quarterly to provide a " forum for specialised and scientific contributions . . ." Further details later but get ready to clear another shelf in the library, my friends.

Construction

TWO-STOREY STRUCTURE *in* LIGHT ALLOY



In the new bus shelter in the centre of Manchester, the structural frame is made entirely of light-alloy sections. The two-storey section is believed to be the first of its kind in Great Britain.

Probably the first two-storey structure in Great Britain to be built entirely with light-alloy columns forms part of a new bus shelter which was opened in Manchester during last December. The shelter, 577 ft long and 28 ft wide, which is capable of accommodating up to 1,000 people queuing for 23 bus services, is built on an island site in Piccadilly, the main square of the city.

The shelter, which was designed by the city architect, Mr. Leonard C. Howitt, M.Arch., M.T.P.I., and built by Robert Carlyle and Company Limited, of Manchester, has several features which contribute to the overall interest and also provide a functional, easy-to-maintain structure. A requirement was that a staff canteen and toilets should be included, and the architect has provided these by designing a two-storey block, 63 ft long and 17 ft high, in the centre of the shelter, with the required facilities housed on the first floor and an enquiry office, meter room and boiler room at ground floor level. The general form of the structure can be seen in the accompanying photograph.

The shelter, which is continuous except for a transverse 36 ft wide slipway for buses at the west end, has a central aisle 12 ft wide throughout its length, with double-queue spaces on either side marked by handrails of aluminium-alloy tube having an outside diameter of 1¾ in. Extensive use has been made of extruded Duralumin H columns and of other aluminium alloys for the window frames and guide rails.

The two-storey central block has a 21 ft radius reinforced concrete shell roof, 2½ in thick, and a first floor of two-way reinforced concrete slabs cast in situ, 4 in thick. The extruded Duralumin columns are 8 in by 4 in with 14 in by 4 in columns at each corner made up of extruded sections welded together. The wall thickness of the columns is 0·28 in. Throughout the remainder of the shelter the 4 in concrete slab roof—designed and built by Matthews and Mumby Limited, Manchester—is supported at intervals of approximately 9 ft by extruded 4 in square Duralumin columns (wall thickness again 0·28 in) interspersed with 6 in by 4 in double-hollow sections, one part of which is used as an integral rain-water down-pipe.

All the structural light alloy sections and plates —to BS 1476 (HE 30) and BS 1477 (HP 30), respectively—were extruded by James Booth and Company Limited, of Argyle Street Works, Birmingham; Saunders-Roe (Anglesey) Limited, Beaumaris, Anglesey, undertook the welding of the base plates, column caps and bearing plates for the roof supports, and also the fabrication of the door pillars and frames, and the columns, some of which are made up of two extruded sections and requiring longitudinal welds of up to 20 ft. The total amount of light alloy sections supplied by James Booth was more than 12 tons; over 900 lb of ⅜ in thick light alloy plate and other small sections—for fabricating into brackets and cleats—were also supplied.

One of the major problems was to keep the layout of the shelter sufficiently flexible for changes in the positions of the 23 bus stands to be made at short notice. This was done by building on a 9 ft grid plan so that the entrances, exits and windows can be interchanged as required. The extruded aluminium window frames are fixed to the supporting columns by cadmium-plated screws and tension plates, with the ¼ in plate-glass windows held in the frames by similar screws and putty. At the base of each frame is a kicking plate of porcelain-enamelled sheet steel bonded to a core of asbestos with an internal sheet of heavily stippled aluminium.

To obviate a monotonous roof line, and to provide visual interest, the roof slabs over the queue spaces alternate in height between 8 ft and 11 ft, but vertical interchangeability of the windows and entrances is facilitated by a transom of uniform depth. A very high intensity of lighting is provided in the shelter so that there is sufficient overspill into the surrounding roadway to dispense with the need for exterior street lighting. All the lighting is controlled automatically from the meter room in the central block.

EXTENSIONS IN LONDON DOCKS

Work has now commenced on the work of developing of No. 4 Berth, South Side, Royal Victoria Dock, London. The new facilities have been designed on the most modern lines to allow the maximum use of mechanical equipment for handling freights.

To the north of the berth an existing tongue of land will be dredged away so as to provide clear access for large liners. The berth itself will be extended eastwards by 80 ft to a length of 1,150 ft and, at its eastern extremity, a new sheet-steel piled quay will extend northwards 400 ft to connect up with the Connaught Road Passage. The whole of the area will be dredged to a depth of 31 ft below impounded water level.

A transit shed 700 ft long by 200 ft wide by 20 ft clear height will be provided and will have 25 sliding doors each 20 ft square. The shed will be approximately twice the size of a normal transit shed to enable cargoes from two vessels to be dealt with at the same time. The existing quay crane track will be extended to cover the length of two normal berths and the entire quay will be resurfaced with a reinforced concrete slab.

The transit shed, which will be the largest belonging to the Port of London Authority, will have a roof of welded tubular steel construction giving a clear span of 200 ft. It will be clad with aluminium alloy sheeting. On three sides of the shed, a 20 ft loading bank will be provided and at each gable end a covered loading area, 150 ft wide by 50 ft deep and with a headroom of over 30 ft, to enable mobile cranes to load and discharge vehicles under cover, is to be built. Road and rail access and an office block are also planned.

The berth will be used by vessels of the United States Lines with whom the Port of London Authority have concluded an agreement. With an unrestricted clear floor area of 140,000 sq. ft the shed will be eminently suitable for the use of mechanical handling equipment and for accommodating container traffic which the United States Lines have under consideration. The berth is expected to be fully completed in the early part of 1960. The estimated cost of the work is over £600,000 and, in addition, four 5 ton and three 3 ton quay cranes of 80 ft radius will be installed. Several contractors have been given tenders for the work but some initial demolition work and all the dredging will be done by the PLA themselves. Construction of the extension to the quay structure will be by John Mowlem and Company Limited, London, S.W.1. The roadway and quay works, and the foundations and floors for the transit shed are to be laid by Higgs and Hill Limited, London, S.W.8. Tubewrights Limited are to erect the superstructure for the new shed. The new cranes will be bought from Stothert and Pitt Limited, Bath.

The new transit shed for the Royal Victoria Dock, London. It will have a welded tubular steel construction that will give a clear internal span of 200 ft. The shed is 700 ft long.

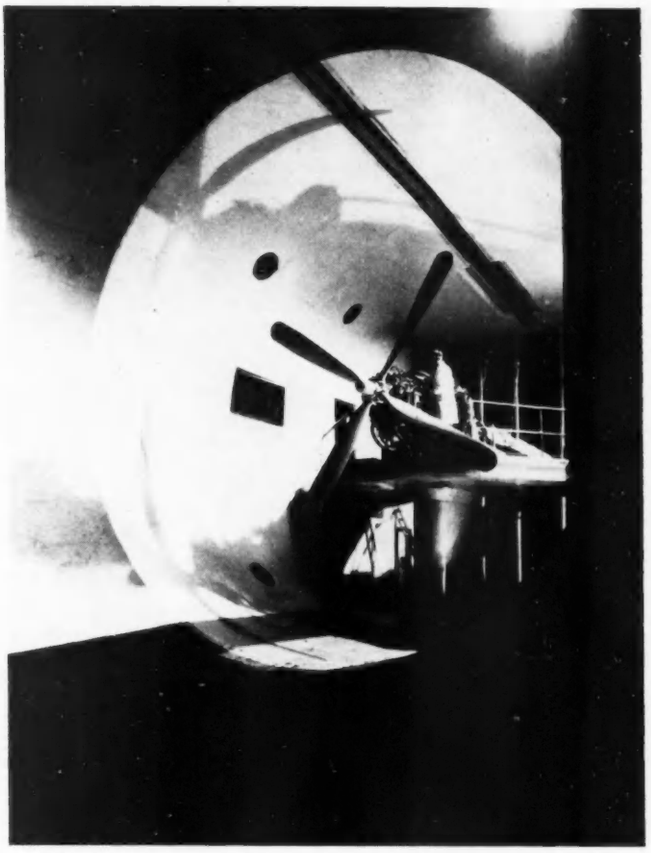
Operation and Maintenance

TWIN BEDS *for* TURBO-PROPS

A new aerodynamically designed, twin cell test bed capable of testing turbo-prop engines of 10,000 e.s.h.p. with propellers of 20 ft diameter passing up to 4,000 lb of air per second has been opened by BOAC at the Nantgarw test site of their repair factories at Treforest, South Wales. The test bed is being used for testing the Proteus 705 turbo-prop engines of the Corporation's 15 Britannia 102's and the Proteus 755 engines of its 18 Britannia 312's.

In designing the internal shape of the engine cells consideration had to be given to the possibility of vibration problems being caused by propeller excitation due to tip clearance in the surrounding cell. Air re-circulation due to pressure difference also presented problems. Following investigation of a number of different shapes, the present circular test section, with a diameter of 28 ft giving a propeller tip clearance of 4 ft was selected.

The aerodynamic shape of the test section was specified by BOAC and it was constructed by British Reinforced Concrete in 8 in thick pre-stressed concrete, which was cast *in situ* and post tensioned. An overall compression loading has been the aim, to reduce fatigue stress due to vibration. All the test equipment was designed to BOAC's specification by Heenan and Froude Limited, who also supplied the equipment and were responsible for its installation.



Column mounting does not interfere with air flow and makes the engine accessible when idling.

In designing the structure for supporting the engine on test, one of the main objectives was to present as little obstruction to air flow as possible, but at the same time the engine had to be readily accessible when idling. This was achieved by carrying the engine on top of a streamlined steel column. This column in conjunction with its steel underframe will take the full power, weight and thrust of the power unit. It is also arranged so that torque reaction measuring equipment can be added later if necessary. At each side of the column just below the engine are " swept back " service ducts extending to the cell walls. These also act as engine access platforms from the control room and cell floor.

An interesting feature is the handrailing along each side of these ducts. It is electrically operated and made to rise with the opening of the control room door. When the engine is ready to run, the handrailing can be made to recede into the leading and trailing edges of the ducts by operating a push button on the control panel. The handrailing does not therefore interfere with the airflow.

A circular nacelle is mounted on top of the column and this carries the engine which is attached to a tubular mounting frame and backplate. Hinged swing bolts enable the engine assembly to be connected quickly.

For propeller handling, a hydraulically operated platform is provided forward of the test stand. This stand has to be retracted to floor level, before the engine is started. An electrical interlock prevents the engine from starting until the platform is fully down.

The control room is alongside the cell and has an observation window just above and a little towards the rear of the engine. Around the window is built the main control panel and this houses engine instrumentation, controls, indicator lamps and starting and switch panels.

The throttle control for the Proteus is the Ultra type similar to that installed in Britannia aircraft. An alternative hand-operated mechanical system is also included comprising levers, brackets and push/pull tubes. The de Havilland propeller control is of the hydraulic type.

At one end of the control room, and forming an extension to the instrument panel, is the engine oil system cabinet. This houses two quite separate systems for different types of lubricating oils. Provision is made for heating, cooling and filtering the oils, the oil/water heat exchangers and filters being below in the plant room. An inhibiting oil system is also installed for use at the end of tests.

The fuel measuring instruments and associated items are contained in a separate ventilated cubicle beneath the control room. Flow indicating meters are remote reading with dials on the main control panel. Provision has been made for taking quick full specific gravity checks. In case of an emergency, there is a push button switch which closes the magnetic valves in the fuel line, stops the extractor fans and cuts off all d.c. services into the Test Cell.

For fuel storage, six underground tanks each 9 ft 8 in diameter by 32 ft long are provided. The capacity of each one is 12,000 gallons. Fuel from the tanks is pumped to the test houses, one pump serving each plant. Pump suction lines and tanks are interconnected however so that fuel from any tank can be delivered to either test cell. A separate high flow pump with filter and meter is installed for unloading fuel from supply vehicles into the tanks.

As a precaution against fire in the engine cell and fuel cubicle, fixed CO_2 extinguishing plant is incorporated. The gas is contained in steel cylinders and can be released from several carefully-placed operating points. In the event of gas being discharged interlocks automatically stop the engines, shut off ventilation, cut the fuel supply and operate an alarm device. Engine starting is done electrically through a 112 volt rectifier set. The silencing of the test bed has been completely successful. The Cullum pier and panel system has been used in the air intake and exhaust with a Cullum detuner for the engine jet exhaust.

The site required a completely new installation of all services, and was not merely an extension to the existing facilities at Nantgarw.

Construction of the test bed was started in March, 1957, and the first cell was completed and ready for use in March, 1958. The main civil engineering contractors were W. C. French and Company Limited.

DIESEL EXPERIENCE

The annual report of working costs and performance of heavy oil engines issued by the Diesel Engineers and Users Association is a running commentary on the progress of the diesel engine in industry. Comparison of the tables from year to year reflects both the improvement in performance and operation of the engines and also the changes in the general economic situation, as evidenced by the relative costs of fuel and wages. In this present report, which was presented to the Association at a meeting held at the Institute of Marine Engineers on 18 December, 1958, mention is made of some changes which are to be made in the future. These will be to follow up the increasing interest displayed in the " Notes and Comments " section in which station operators give brief notes on their successes—and failures. The main impression once again is that the diesel engine continues to be a very reliable prime mover.

Working costs are quoted from 107 sources in this country and abroad, covering some 540 individual engines operating in England, Africa, Australia and Fiji to name only some of the places. In spite of this

Continued on next page

Continuing

Operation and Maintenance

wide distribution, out of the 82 generating stations listed, 50 of them reported gross costs ranging between 1·3 and 2·3 pence per unit generated, a remarkable result considering that gross cost includes fuel, oil, stores, wages and maintenance. The extremes were 0·328 pence at Bahrain where the engines run on natural gas and 14·648 pence at Blackpool, which is perhaps hardly a fair result as the plant is run only during emergencies, making the overheads disproportionately high. For pumping stations in Britain the gross cost per water-horse-power-hour ranged from 1·410 to 3·881 pence, there being some correlation between cost and the number of water-horse-power-hours run. There is, however, one figure in the tables which does show a surprisingly wide variation, and that is the lubricating oil consumption. Discounting a standby plant and a gas-turbine, the range is from 1,120 b.h.p. hours per gallon to 8,210 b.h.p. hours per gallon. For the standby plant and the gas-turbine the figures were 684 and 9,420 b.h.p. hours per gallon respectively.

The " Notes and Comments " section is always of interest and can be of considerable importance to both users and designers of machines. This point was brought out by one of the correspondents and marked by Mr. W. Howes in his introduction. This year there are reports of 17 sources in this country and 1 abroad in which some degree of waste heat recovery has been installed. All unite in showing the economies that have resulted—savings of £3,000 per annum and over are named, and in one installation the heat recovered amounted to 24 per cent of the total fuel bill. There can be no doubt at all that waste heat recovery is a means of reducing overall costs and of combating the steady trend towards higher prices. Improved performance has followed the use of heavy-duty and detergent oils. However, failure of oil, water and fuel pipes is mentioned several times as the causes of involuntary shut downs. Not so much is said about automatically controlled sets in this report, but one case is referred to in which better performance has been obtained by its use. The prize for long running probably goes to one engine that has completed 124,000 trouble-free hours.

Some interesting figures are quoted for dual-fuel engines particularly those at sewage works. In one, the equivalent cost of the gas used would have been £37,000 and in another £25,000—no mean economies. Other stations abroad run on producer gas made from anthracite or wattle wood.

An unusual failure reported at one station was fracture of some of the engine long bolts. Detail examination revealed that the fracture started at a dimple that had been machined in the bearing surface of the bolt to take a grub screw used during assembly. This emphasises the need—long realised by designers—for avoiding anything that could be a stress raiser, and also points out that constant watchfulness must be exercised at all times to follow this principle. Another source reports cylinder heads cracked at the valve seat where the metal has been machined away to allow the fitting of inserts. It would appear that insufficient is then left to take the extra loading imposed by scale formation. Worn valve seats are now being repaired by building up with hard facing metal and subsequent machining, a process that has proved satisfactory over a period of 2½ years. More and more planned maintenance is proving its worth in all installations.

Engineering at Home

STRUCTURAL ENGINEERING *for* CABINET MAKERS

It is a remarkable fact that, up to very recent times, the structural design of furniture has proceeded entirely by rule of thumb—and the majority of furniture makers are still using such methods. During the last few years, however, the research department of the Furniture Development Council have been carrying out experiments and analyses on open box type structures representative of wardrobes, cupboards, and similar items. So far as is known, no other country has been working on similar lines, and the results of the Council's work should give British manufacturers the opportunity to make a major breakthrough in the design of low-cost, lightweight but rigid furniture.

The Council's findings were published firstly in a detailed research report, " The Theoretical and Experimental Analysis of Cabinet Structures," by Mr. T. Kotas; and now, in a simpler textbook version, *Design Manual for Cabinet Furniture*, published on behalf of the Council by Pergamon Press Limited (17*s* 6*d*).

The principles worked out by the Council have already been applied by some of the more enlightened furniture makers with quite spectacular results in enhanced stiffness and economy in material. Briefly, there are two basic findings. The first, concerned with frame and panel type construction, is that the frame members round the open face, and the joints between them, provide most of the rigidity. The second is that an open-sided box can be made more rigid by stiffening only one side of the box—for instance, by using a torsion-box construction for the base member of a wardrobe. As a corollary, " inside corner rails and stiles, linings, etc., are of little use for stiffening a cabinet, and, for economy of material, their size should be as small as possible."

The new design methods are particularly valuable when applied to " knock-down " furniture, which has hitherto proved difficult to make adequately stiff.

The Council hope that the new textbook will be widely used in industrial design schools and technical colleges, and that the new ideas, when assimilated, will fertilise new developments in the forms of furniture.

TRANSISTORS *for the* HOME CONSTRUCTOR

Two further types of transistor are being made available to home constructors by Siemens Edison Swan Limited, 155 Charing Cross Road, London, W.C.2. They are the Ediswan-Mazda XA103 and the XA104, and cost 15*s* and 18*s*. The latter is a general purpose radio frequency transistor for the long and medium wavebands, having a minimum common base cut-off frequency of 4 Mc/s; it can be used as a frequency changer or oscillator. The XA103 is an intermediate frequency amplifier with a minimum common base cut-off frequency of 2 Mc/s. For both types the maximum peak or mean collector-to-emitter voltage is 12 v. The minimum small signal current gain is 15 for the XA103 and 18 for the XA104. Audio frequency transistors XB102 and XB104 are now also available at 10*s*.

Getting the most from TAPE, DISC *and* RADIO

The BBC are putting on a programme for people interested in high fidelity audio equipment and tape recording. It is entitled " Sound " and will take the form of a fortnightly series on Mondays at 6.45 p.m. in Network Three. Each programme will last for half an hour. The first was on 5 January.

There are at least a quarter million tape recorders in Britain and the number is rising rapidly. The potential audience for this series is therefore large. A very wide field will be covered and the BBC say they will make efforts to please everybody.

In the first programme in the series there was a talk about electronic music and *musique concrete*. There was also a talk about the problems connected with the stereophonic production of " Alice in Wonderland."

OIL-FIRED WATER HEATER *with Natural Draught*

An oil-fired boiler that provides hot water for household use is manufactured under licence in this country by Kimber and Lovegrove Limited, London, S.W.19. It is of Canadian design, has a diameter of 10 in, and a height of 3 ft 6 in. Called the " Silver Flame," it is dependent on natural draught for its operation and requires no electricity supply. The continuous measured output is 15,000 Btu per hour. It is not intended for space heating.

The boiler jacket is of all-welded steel construction and is treated for rust protection. Alternatively, a stainless steel boiler can be supplied. To facilitate installation, the boiler can be turned into six different positions in relation to the burner by means of location bolts.

A draught stabiliser is fitted as an integral part of the boiler. The burner is of natural draught vaporising pot type, automatically regulated by a thermostat. A control valve regulates the flow of oil to the burner between high flame (1·5 pints per hour) and low flame (0·25 pint per hour), according to the temperature of the boiler water. The temperature required is set by turning a knob on top of the control box to any one of four positions. The control box also incorporates a safety device that shuts off the supply of oil should the flame be accidentally extinguished. The recommended capacity of the water tank is 25 to 30 imperial gallons, and 160 or 275 gallon oil-storage tanks are available. The heater costs £47 10*s*.

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